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THE ART OF PRESERVING THE EYE-SIGHT.

From the French of ARTHUR CHEVALIER.

IN order that we may know how to preserve our eye-sight, it is necessary that we should, first of all, understand the structure of the eye in its minutest details. Having made ourselves familiar with this, the next question to answer is, "How do we see?" It is only by making ourselves thoroughly familiar with these two matters that we shall be able to judge properly of whatever modifications may arise, and direct such a course of hygiene as the latter demand.

We will commence then with:

I. *The Anatomy of the Eye.*—The eye is held in its place in a bony cavity, called the *orbit*, or "socket," by the aid of six

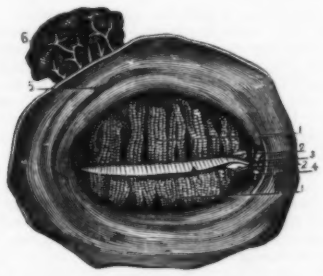


FIG. 2.—THE INNER SURFACE OF THE EYELIDS.

1, 1. Meibomian glands. 2, 2. Lachrymal canals. 3, 4. Lachrymal caruncle. 5, 6. Lachrymal gland.

muscles. These are (Fig. 1): 1st, the *internal rectus;* 2d, the *external rectus;* 3d, the *superior rectus;* 4th, the *inferior rectus;* 5th, the *superior oblique;* and 6th, the *inferior oblique.*

The *internal rectus*, the shortest of these muscles, is designed for drawing the eye in a direction toward the nose. The *external rectus* draws the eye outward toward the temple. The *superior rectus* is designed for raising the eye upward; the *inferior rectus* draws it downward. The *superior oblique*, the largest of the muscles of the eye, passes forward to near the upper edge of the socket, and nearer the nose than the center of the socket, where the tendon of the muscle passes through a tendinous loop, when it turns back and becomes attached to the upper, outer and back part of the eyeball. When this muscle contracts, therefore, it rolls the eye inward and down, as when the eye is directed toward the tip of the nose. The *inferior oblique* is attached by one extremity to the front part of the socket near the nose; it then passes under the eyeball and becomes attached to its back part, between the *external rectus* and *inferior rectus* muscles. It tends to roll the eye upward and outward, causing it to look toward the outer end of the eyebrow.

Such are the muscles charged with moving the eye in all directions. Five of these muscles arise from a fibrous ring situated at the bottom of the orbit. The movements of the eye are accomplished with great smoothness and ease, for the entire ball is surrounded by a cushion of fat.

These muscles receive branches from the third, fourth and sixth pairs of nerves. The fourth pair, or pathetic, leads to the superior oblique muscle, the sixth pair to the external rectus; the five other muscles (and among these is included the *levator* muscle of the eyelid) are animated by the third pair, or common *oculo-motor* nerve. In *divergent strabismus*, or "wall-eye," the *oculo-motor*

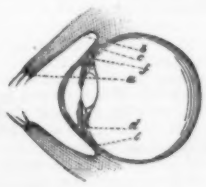


FIG. 4.—SECTION OF THE EYEBALL, AND EYELIDS ATTACHED.

a, b. Conjunctiva of eyelid. *c, e.* Conjunctiva of eyeball. *d, f.* Cornea.

nerve is paralyzed, and from this fact five muscles become powerless; the external rectus alone continues to act and draws the eye outward toward the temple. Paralysis of the sixth pair of nerves is followed by *convergent strabismus*, or "cross-eye," an affection in which the eye is directed toward the nose. From these examples it may be seen how necessary it is to study these muscles carefully.

As to the blood vessels, we may remark that the largest arterial trunk arises from the *internal carotid* and constitutes the *ophthalmic artery;* at the inner angle of the eye, the latter divides into two terminal branches—the frontal and nasal. The branches of the ophthalmic artery are ten in number; the names of these it is not necessary for our present purposes to give. As to the veins, the most important is the ophthalmic; then there are

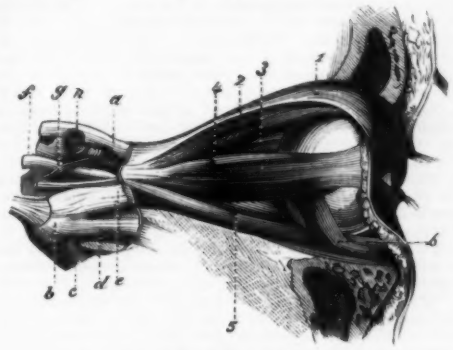


FIG. 1.—MUSCLES OF THE EYE.

1. Levator muscle of the upper eyelid. 2. Superior rectus. 3. Interior rectus. 4. External rectus. 5. Inferior rectus. 6. Inferior oblique. *a*, Optic nerve. *b*, Gasserian ganglion. *c*, Inferior maxillary nerve. *d*, Superior maxillary nerve. *e*, Willis's bands. *f*, Oculo-motor nerve. *g*, Pathetic nerve. *h*, Carotid artery.

various divisions that extend to the forehead, the *lachrymal sac*, and the other parts of the eye.

Before entering upon a description of the eye, now that we are acquainted with the muscles that serve to direct it, let us speak of the eyelids, those valls designed for protecting the apparatus of vision. As every one knows, these are

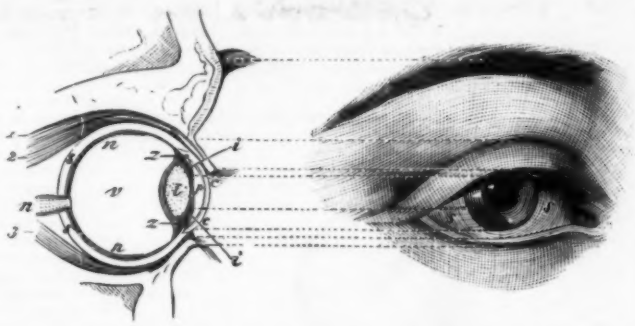


FIG. 5.—THE EYE, AND THE CORRESPONDING PARTS SHOWN IN A VERTICAL SECTION.

1. The levator muscle of the eyelid. 2. Superior oblique muscle. 3. Inferior rectus muscle. *n*, Optic nerve, which spreads out internally to form the retina, *n'*, *n'*. *v*, Vitreous humor. 2, 2. Ciliary processes. *l*, Lens. *p*, The anterior chamber. *c*, Cornea. *i*, Iris.

burdened by the eyelashes, which, as well as the eyebrows, prevent dust and foreign bodies from falling into the eye.

On examining the inner surface of the eyelids (Fig. 2) there may be seen, imbedded in the substance of the cartilages, minute pieces of apparatus consisting of coiled tubes, although they have the appearance of parallel strings of pearls (Fig. 2, 1). These are called the *meibomian glands*. They secrete a kind of fatty substance, which, oozing out through numerous small openings on the edges of the lids, prevents the tear-fluid from running over upon the cheek.

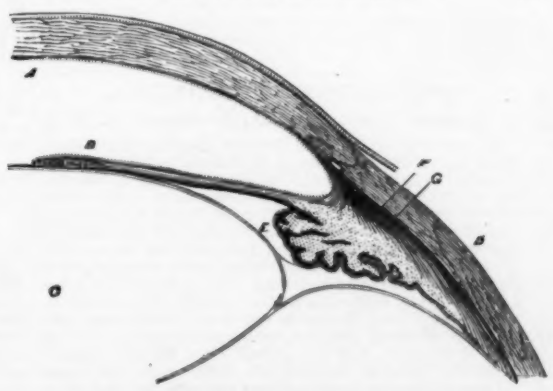


FIG. 6.—RODS AND CONES (Highly Magnified).

A. Cornea. B. Iris. C. Crystalline lens. D. Sclerotic. E. Ciliary process. G. Radiated part of ciliary muscle. F. Circular part of same.

The tear-apparatus consists of the *lachrymal gland*, the *lachrymal caruncle*, the *lachrymal points*, the *lachrymal canals*, and the *lachrymal sac*. The *lachrymal* or *tear gland* (Fig. 2, 5 and 6) consists of a small organ, of about the size and form of a sparrow's egg, of a whitish-yellow color, situated above the eye, a little outside of the middle of the socket, and near its front edge. On raising the upper eyelid, a part of this gland may be perceived. In this the tear-fluid is formed from the blood. At the inner corner of the eye, and, as it were, between the ball and the inner corner of the lids, is a small, somewhat prominent substance called the *lachrymal caruncle* (Fig. 2, 3 and 4). It is of a pale red in ill-health and a bright red in health; it is the source of the whitish secretion which so constantly forms at the inner angle of the eye. On its surface is seen upon examination a number of very minute hairs, which sometimes become large and very

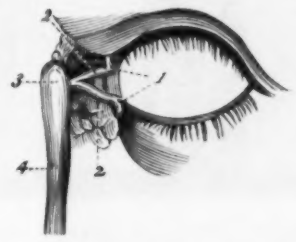


FIG. 3.—THE TEAR-APPARATUS.

1, 1. Lachrymal points. 2, 2. Lachrymal canals. 3. Lachrymal sac. 4. Nasal canal. 5. Lachrymal gland.

troublesome. When this occurs they should be drawn out, and the operation repeated as often as necessary. Near the caruncle may be seen two orifices, which further examination will show to be the opening of two minute tubes called the lachrymal canals (Fig. 2, 2, and Fig. 3, 2 and 2); these come around and open into a large tube called the lachrymal sac, or tear duct (Fig. 3, 3). This opens into the nose. The tears are of use, ordinarily, to moisten the eye and afterward the nose. When the flow of tears is so copious that the lachrymal canals cannot carry them off into the nose, the surplus runs over on to the cheek.

The anterior surface of the eyeball is covered with a delicate mucous membrane called the *conjunctiva*, which is reflected upon the lids and forms their internal surface (Fig. 4, *a, b, c, d, e, f*); this membrane also invests the lachrymal canals and the lachrymal sacs, and, extending downward through the nasal ducts, becomes lost in the *nasal fossæ*, and then acquires new properties; it is called the *pituitary* or *schneiderian membrane*. It will therefore be seen how liable the lining of the eye will be to disease if a person take cold, both on account of its similar structure to the lining of the nose and its intimate connection with it.

Let us now look at the different parts of the eye properly so called. The form of the eyeball is that of a sphere, of about one inch in diameter, having the segment of a smaller sphere ingrafted on its anterior surface, which thus increases its anterior-posterior diameter. Fig. 5 represents a vertical section of the human eye. The outer part of the eyeball, from its color, is commonly called the "white of the eye," and, from its firmness, the *sclerotic coat* (Fig. 5, *s, s*). It has two openings,

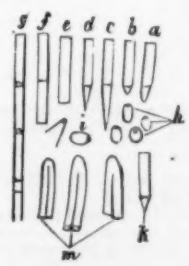


FIG. 8.

a large one in front to admit light, and a much smaller one, a little to the inside of the back center, to admit a bundle of nerves, called collectively the optic nerve. From the form and structure of the sclerotic it yields but slightly, except to great pressure. It is thicker at the back than at the front part.

The transparent *cornea* (Fig. 5, *c, c*) forms the front part of the eyeball; it is fitted into the sclerotic coat very much as the crystal of a watch is fitted in its case. It resembles perfectly the segment of a smaller sphere fitted to one that is larger. It is formed of

four layers, differing in their nature: namely, the *conjunctiva*; the *cornea proper*, consisting of several thin lamellæ connected together by an extremely fine areolar tissue; the *elastic cornea*, a fine, elastic and exquisitely transparent membrane; and the *lining membrane* of the anterior chamber of the eyeball. The elastic cornea is remarkable for its perfect transparency, even when submitted for many days to the action of water or alcohol, while the cornea proper is rendered opaque by the same immersion.

Immediately beneath the sclerotic is found a membrane of a rich chocolate-brown color externally and of a deep black within; it is called the *choroid*. This membrane extends from the posterior opening of the sclerotic to the ciliary processes; its internal layer is a delicate membrane com-

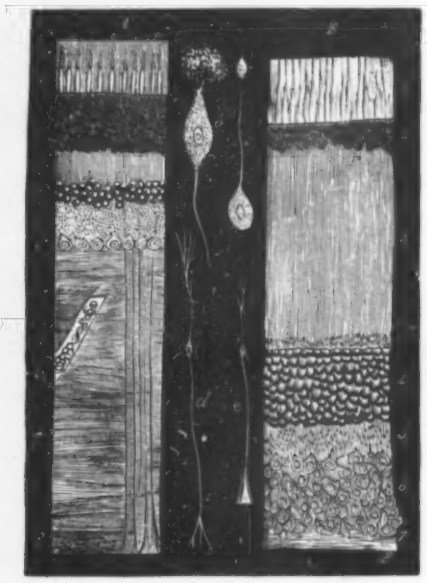


FIG. 7.—VERTICAL SECTIONS OF THE RETINA.
(Highly Magnified.)

1. Jacob's layer of rods and cones (A and B, 1). 2. External granular layer (A, 2). 3. Intermediate layer (A, 3). 4. Myelocytes layer (A, 4). 5. Gray granular layer (A, 5). 6. Ganglionic layer (A, 6); *a*, *b*, ganglions more highly magnified. 7. Fibrous layer (A, 7). 8. Hyaloid membrane.

posed of several laminæ of hexagonal cells which contain the granules of *pigmentum nigrum* which give the membrane its black color. In animals the pigmentum nigrum is replaced by a layer of metallic brilliancy called the "tapetum," and it is owing to this that their eyes shine in darkness. The external layer of the choroid consists principally of veins arranged in a peculiar manner; hence they have been named *vorticose veins* (*venæ vorticosæ*).

The *ciliary ligament*, or circle, is a thick grayish band, almost a line or two wide, situated between the choroid, the iris and sclerotic. A minute vascular canal is found within the ciliary ligament, called the *ciliary canal*, or *canal of Fontana*, from its discoverer.

The *iris* (Fig. 5, *i*, *i*), so named from its variety of color in different individuals, is a membranous partition placed vertically behind the cornea, in the anterior part of the eye. It is pierced somewhat to the nasal side of its center by a circular opening (Fig. 5, *p*) called the *pupil*. The iris is composed of two layers—a *muscular*, consisting of from 70 to 80 fibers which converge from the circumference toward the center, and have the power of dilating the pupil; and *circular* fibers which surround the pupil like a sphincter, and by their action produce contraction of its area, according as more or less light is necessary for vision. Light, electricity, strychnine and the calabar bean contract the circular fibers without acting on the radiating ones. Belladonna paralyzes the circular and contracts the radiating fibers. The *ciliary processes* (Fig. 5, *s*, *s*) consist of a number of triangular folds, formed apparently by the plaiting of the middle and internal layer of the choroid. They are placed behind the iris and are about sixty in number. Their exterior surface is covered with a thick layer of pigmentum nigrum; when this is washed off, the processes are of a whitish color.

The *crystalline humor*, or *lens* (Fig. 5, *l*), is more convex on the posterior than on the anterior surface; in the fœtus it is nearly spherical.

The axis of the crystalline lens corresponds with the center of the pupil. Its diameter is four lines and its thickness about two lines. It is placed behind the pupil—its anterior surface bathed by the *aqueous humor*, and its posterior face imbedded in the anterior part of the *vitreous humor*.

The space intervening between the cornea and the iris is called the *anterior chamber* (Fig. 5, *p*). The *posterior chamber*, less than half a line in depth, is situated between the internal face of the iris and the external face of the lens.

The *aqueous humor* (Fig. 5, *p*), a transparent, weakly-albuminous fluid, is situated in the anterior and posterior chambers. The *vitreous humor* (Fig. 5, *v*) is an albuminous and highly transparent fluid, inclosed in a delicate membrane, the *hyaloid*. It forms the principal bulk of the globe of the eye. The crystalline lens, retained in its place by a prolongation of the *ciliary zonule*, is composed of a capsule which contains a small quantity of fluid, called *liquor Morgagni*. The lens itself consists of concentric layers, of which the external are soft, the next firmer, and the central form a hardened nucleus. Immediately around the circumference of the lens is a triangular canal—the *canal of Petit*—which allows the ciliary muscle to move the lens.

The *retina* (Fig. 5, *n*, *n*), a knowledge of the structure of which is of the utmost importance in the theory of vision, is a pulpy, grayish membrane (transparent during life), extending from the optic nerve (of which it is usually regarded as an expansion) to the lens; it lies immediately upon the choroid, but does not adhere to it. The retina is not a simple membrane; it is formed, according to Robin, of eight layers (Fig. 7), the innermost of which, in contact with the hyaloid membrane, is called the fibrous gray layer; outside of this comes the gray vesicular layer, analogous to the vesicular matter of the brain. Next comes the granular layer, which, as its name imports, consists of a congeries of granules. Yet again, outside of the granular layer, comes a delicate sheet, known as Jacob's layer of rods and cones (Fig. 7, A and B, 1). The fibers of the optic nerve are in reality all connected in such a way that, passing in a radial direction as respects the globe of the eye, all these different elements are successively combined, constituting what is termed the radiated fiber system. Thus from each of the fibers of the optic nerve a thread-like body passes radially through the thickness of the retina, including in its outward passage a vesicle, and again beyond that a granule, and still further a cone, and terminating in a rod; so that from the extremity of the rod there is a continuous communication through the thickness of the retina to the fibers of the optic nerve. The rods are therefore to be regarded as the termination of the optic fibers, and the faculty of vision belongs alone to the layer containing them.

In the center of the posterior part of the eye the retina presents a circular spot, about the twentieth of an inch in diameter, called the *foramen of Soemmering*; it is surrounded by a yellow halo (*limbus luteus*) and is frequently obscured by a fold of the retina. According to Cuvier it exists only in animals having the axes of the eyeballs parallel with each other, as man, quadrumana, and some saurian reptiles, and is said to give passage to a small lymphatic vessel.

The *optic nerves* (Fig. 9), two in number—one for each eye—arise from a portion of the brain called the *optic lobes*, and intercross. At their origin they are wide apart, then they cross each other and again diverge to penetrate the orbits, where, spreading out over the choroid, they form the retina. This reunion of the two optic nerves explains why vision is simple, although we possess two eyes. But this will receive our attention hereafter, when speaking of vision.

(*To be continued.*)

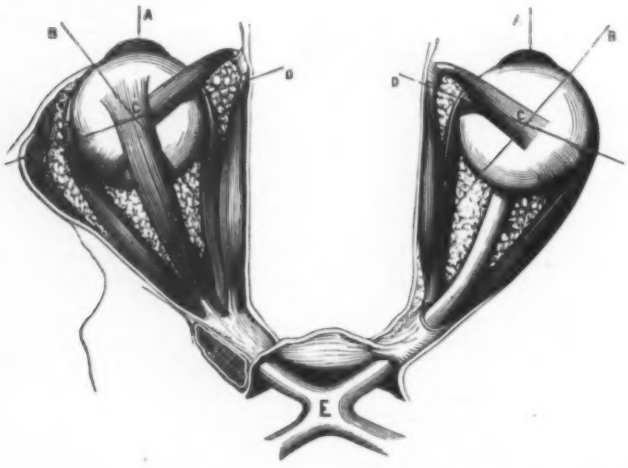


FIG. 9.—THE APPARATUS OF VISION.

A, A. Parallel optic axes. B, B. Axes of revolution of the oblique muscles. D, D. Axes of revolution of the superior and inferior recti. E. Commissure of the optic nerve, showing the crossing of the nervous fibers.

THE TREATMENT OF DIPHTHERIA.

By LOUIS WEIGERT, M. D., Amsterdam, N. Y.

READING the report of the Board of Health of New York, which stated the mortality of diphtheria in that city and Brooklyn to be 40 per cent., I think it my duty to acquaint the profession with some facts concerning that terrible malady—facts which I have gleaned during my residence here—hoping and believing that it might be the means of reducing the death rate. When I arrived here on the 11th of last January I was informed that diphtheria had raged in Amsterdam and the surrounding country since early fall as a most fearfully malignant epidemic, which had already deprived almost every family of one or more of its members, and that all those attacked, with the exception of at the most 10 per cent., had succumbed to the disease. Investigating the causes of death—I refer to the immediate causes—I learned that by far the greatest majority had died of asthenia, induced partly by the prostration incident to the disease, partly by the high temperature which literally consumed the patients, and last, but not least, by the want of proper nourishment and stimulation. Only a very small number died of asphyxia. The following is an account of my observations and the results that I have thus far obtained: As a rule I was called from 12 to 24 hours after the patient began to complain of the following symptoms—vomiting, headache, pain in the bones, sore throat, fever—either one or more, or all combined. Their uniform condition was, temperature from 103 to 104½° in axilla (thermometer allowed to remain *in situ* for five minutes), pulse 120 to 180, cervical glands enlarged, tonsils and pharynx inflamed, the former presenting in all cases a varying amount of membrane, usually of about the size of a five cent nickel, the exudation forming a continuous membrane in all but five cases, appearing in the latter in small scattered patches. Both tonsils were involved in 90 per cent. In two cases pressure upon the larynx was painful. I have now treated 50 cases, only two of which have terminated fatally. Convinced that nothing but heroic treatment could combat successfully with this scourge, I decided upon the following treatment, which I have pursued in all the cases: I prescribed no less than gr. v. of sulphate of quinine (either in gelatine coated pills or in a mixture with the compound elixir of licorice) every two hours, and, as a rule, that amount was sufficient to reduce the temperature after about 12 hours to below 101°, at or below which degree I maintained it during the entire course of the disease. I never decreased the dose of quinine first given, but increased—according to requirements—the intervals between the doses; in some cases I was compelled to administer as much as gr. viij every two hours to obtain the desired effect, and that even to as young a child as six years old. The tinnitus aurium and other symptoms of cinchonism were very mild if they existed at all, being entirely absent in about 33 per cent. In some instances I noticed that, after the disease had run its course, the continuance of the use of quinine would maintain the temperature at from 1½° to 2½° degrees above the normal, the fever only subsiding after the withdrawal of the drug. I gave to all the following mixture: Kali. chlor., ℥ ij; aquæ et glycer., aa ℥ viiij; tinct. fer. muriat., ℥ ss (reducing the amount of chlorate of potas. in very mild cases to ℥ iss or even ℥ i). In this proportion there is, of course, an excess of potassium chlorate, which is deposited in minute crystals. I directed the bottle to be well shaken and ℥ i to be given every 15 minutes, and, as I did not permit the imbibition of anything within 5 minutes after each dose, I obtained both the constitutional and the local effects.

I continued the use of this, day and night, until I could perceive that the extension of the membrane was checked, and that occurred, as a rule, after 24 to 72 hours; only in three cases did I fail to make any perceptible impression upon the local disease. On the 3d to 5th day the membrane begins to alter in color—it becomes a dark, dirty gray; and on the 6th to 7th day it commences to fall off, usually in small fragments, so that on the 8th to 9th day the throat is entirely clear; after which time I still continue the use of the potassium chlorate mixture for 2 to 4 days, of course in diminished doses. I have noticed one very remarkable effect of the chlorate of potas., viz., after the absorption of 4 to 6 ounces, generally about the 7th day there appeared in about 35 cases (the balance had taken much smaller amounts) an eruption which in 6 cases bore a most striking resemblance to measles and scarlet fever—on the first day to the former and 24 hours later to the latter—covering the entire body and face, and disappearing by gradually fading out, but only after the discontinuance of the potassium chlorate. I administered gentle cathartics daily, unless the patients had natural evacuations. I never attempted to check any emesis (which was often induced by the drugs), believing that it reduced the fever, and, toward the termination of the disease, certainly aided in the expulsion of the membrane. During the entire course of the malady I had a wide strip of flannel, wet with ice-water, applied to the patients' throats and covered by a dry flannel bandage, and had the former renewed as soon as it became dry and warm (at first every 3 to 4 minutes). It was gratifying to see how well the poor sufferers liked these cooling applications, especially after they had had pork, pepper, mustard, kerosene, etc., around their necks for some hours prior to my arrival, and that was the case in 48 out of the 50. Even the youngest children—those but 3 years old—would remind their attendants of the necessity to renew the bandages. It is needless to say that I insisted upon thorough ventilation of the sick-room.

And now as regards nourishment: The patients received 2 quarts of milk, one pint of beef-tea—the extract of one pound of meat—6 eggs, and two ounces of brandy daily; these, the minimum quantities, they were forced to take, but were allowed to have as much more as they would accept. As soon as convalescence began, I permitted the judicious use of solid food. In 3 cases—one 2½ and the other two 4 years old—there was hoarseness and dyspnœa (severe only in one), beginning in two on the 5th day, and in the other on the second day; to them I administered emetics (1/10 gr. of sulphate of apomorphia, hypodermically) daily, and had them inhale the vapor of water every ½ to 1 hour for 5 minutes; all three recovered. Fetor was present only in 3 of my cases, whereas it was a constant occurrence in others.

My two fatal cases both died of collapse, and both after convalescence had set in; one was a girl, 4 years old, in whom the disease had been exceptionally severe, and the other was a lad, 13 years old, who had always been feeble and whose lungs were affected. The local manifestation of the disease was confined to the throat in all my cases, excepting in the first-mentioned fatal one.

Dr. R. J. Cullen, a young physician who has also settled here recently, has carried out this treatment in all his cases of diphtheria, amounting to about 20, all of whom recovered. His observations fully coincide with mine. One of his patients was but eight months old.

In the above I have mentioned no new drug for the treatment of this disease. I have used those hitherto known to be efficacious, and employed by many; hence my only claim is that I have obtained from them their full effects.—*Hospital Gazette.*

SKIMMED MILK IN DIABETES.

DR. W. H. JONES reports a case of a man, aged 42, who following severe mental strain had diabetes, passing 8 to 10 pints of urine daily; urine had a s. g. of 1,047°, and contained an abundance of sugar. Milk was given after every vestige of cream had been removed, and in quantities not exceeding 7 pints *per diem*. In 5 days the s. g. fell to 1,038°, and the quantity to 4 pints daily. In less than 30 days the s. g. reached 1,018°, and the quantity of urine soon diminished to 2½ pints daily, the sugar having completely disappeared. A return to ordinary diet, somewhat later, caused no relapse of the diabetes.—*Chicago Medical Journal and Examiner.*

A CASE OF HYDROPHOBIA.

By CHARLES C. PIKE, M.D., of Peabody, Mass.

FEBRUARY 20th, 1878, at about six o'clock in the evening, I was called to see Wm. M., a young man, twenty-six years old, by trade a morocco dresser. I found him lying on a sofa, dressed. The patient said that he had not felt well for three days, but that he had worked at his trade the day before; he complained of a dull heavy pain in his right shoulder, shooting up toward the neck, and sometimes extending downward toward the elbow. He said that occasionally when he attempted to swallow anything, whether fluid or solid, but more particularly if it was fluid, he felt a choking sensation. He had been unable to eat anything since the morning before. He felt hungry, but could not bring himself to the necessary effort of trying to swallow. His pulse was 86, full and strong, temperature 99°. Tongue slightly furred; breath somewhat offensive. Mucous membrane somewhat congested, especially about the fauces; no membranous patches; saliva very viscid. Noticed that there seemed to be a general capillary turgescence of all exposed parts of the body. Suspecting that this might prove to be a case of tetanus, I questioned him carefully, but could learn nothing to confirm the suspicion. I then thought of hydrophobia, although he had not mentioned having been bitten. Concerning this point I made inquiries of his boarding mistress, and learned from her that on Christmas day, just eight weeks before, he had been severely bitten through the right hand by a Newfoundland dog; that a physician cauterized the wound with nitrate of silver; that the dog had been followed, but was not found, so that whether it was rabid or not could not be learned. I expressed fears, to his friends only, that the poor fellow had hydrophobia. Ordered him 20 grains chloral hydrate and 30 grains brom. pot., by clyster, together with beef tea and milk every four hours, all of which were retained.

February 21st, morning. Patient no better. Pulse 90; temperature 100°. Had had only a few minutes' troubled sleep at a time. Looked very haggard and worn, and presented a sallow appearance, which strongly reminded me of the cachexia of puerperal fever. Patient had not been able to lie down, any attempt to swallow bringing on slight spasms, which were also easily produced by a very slight draught of air, or even the jar produced by walking across the floor. Could suck pieces of ice; ordered frozen milk; continued former clysters; also gave $\frac{1}{30}$ of a grain of atropia, hypodermically.

February 21st, evening. Pulse 108; temperature 101·5°. Could not swallow. Had frequent involuntary spasms of muscles of the throat and chest. The tired, careworn look was not as noticeable, but had given place to a wild maniacal look. Complained much of the sense of constriction of the throat; also of the pain in his shoulder, but said he was better than yesterday, only at times he felt as if he should lose his mind. Discontinued the chloral hydrate and bromide of potassium. Continued beef-tea and milk injections. Also gave $\frac{1}{30}$ of a grain of atropia, hypodermically.

February 22d, morning. Patient decidedly worse. Pulse 120; temperature 102°. Seems very nervous indeed. Bowels moved slightly. Repeated the atropia, $\frac{1}{30}$ of a grain. I may here mention that from the first the pupils were rather dilated, and that the use of the atropine did not appreciably affect their size; neither did it seem to increase or diminish the sense of constriction or choking.

Noon. No particular change. Pulse 132; temperature 130°. Met Dr. A. H. Johnson in consultation. He suggested the external application of tincture of aconite, chloral hydrate, and camphor, in equal parts, to the whole length of the spine, also the hypodermic use of chloral hydrate and atropine. No mention had heretofore been made of hydrophobia to the patient, neither had he referred to the bite in any way. Through the over-officiousness of a friend of the patient, an irregular practitioner saw him, and in his presence remarked that it was a case of hydrophobia. Whereupon the patient, who had evidently been hoping against hope, exclaimed, "Oh, God! I am sorry you mentioned that," and very soon afterward became frantic with distress. Also became somewhat delirious; when much excited noticed that he could chew pieces of beefsteak, and even swallow them, with some little difficulty. Also noticed that he did not mind a slight draught of air, when not paying attention to it. From this time forth he said that he should die, and talked freely of his having been bitten, etc.

2 o'clock, P. M. Patient had become so wild and unmanageable that nothing could be done for or with him. His attendants becoming afraid of him doubtless increased his excitement. He would get down upon his hands and knees and moan with distress; and when trying to rid himself of the terribly viscid mucus which seemed to fill his throat, the masseter muscles would contract spasmodically, causing his jaws to come together violently, all of which was promptly construed into "dog practice" by his horrified attendants. I thought it best to administer an anæsthetic, which I accordingly did, assisted by several men. Found the chloroform acted promptly and kindly. While under its influence I had a camisole put upon him. After recovering from the anæsthetic he was somewhat delirious, but very quiet, and almost entirely free from spasms. Was very malicious and treacherous; would occasionally kick or spit at his attendants if they gave him a chance to do so.

Evening. Patient again very restless, though not as much so as heretofore. Pulse 136, temperature 105°. Talked rationally; asked to have the camisole removed; said he would do no harm. I therefore removed it. Looked and seemed very grateful, but was very nervous, constantly patting his feet on the floor, and endeavoring to clear his throat. Could lie down; has chewed and swallowed several small pieces of beefsteak. Gave beef tea and milk injection, which was retained; also gave, hypodermically, chloral, ten grains, atropine, one twentieth of a grain, after which he seemed more quiet. He remained comparatively comfortable for several hours, although making frequent attempts to raise the viscid mucus from his throat. About 2 o'clock A. M. he became more restless, sighing and talking incoherently; evidently was sinking. I was summoned, but when I arrived he had just expired, apparently dying from nervous exhaustion. I would add that several medical gentlemen besides Dr. Johnson and myself saw the case, all confirming the diagnosis.

Autopsy, fifty-five hours after death, conducted by Dr. A. H. Johnson. Rigor mortis extreme. Appearance of the cadaver unusually revolting, owing to the oozing of the bloody and frothy mucus from the mouth and nostrils. A peculiarly brutal and malicious expression, from the rigidity of the muscles of the face, and the mahogany color of the skin of the upper half of the chest, of the throat, and of the right arm. Considerable decomposition apparent over the abdominal surface. Cicatrix of the bite presented no remarkable appearance. Brain.—Blood vessels much distended; convolutions somewhat flattened. Choroid plexus somewhat congested. Small amount of fluid in ventricles. The cortical substance congested so as to sharply and strongly contrast with the white fibrous portions. Corpus striatum darker than usual; is of a light chocolate color. Meso-cephalon greatly congested. Heart.—Right ventricle and auricle moderately distended with dark fluid blood; lining membrane of right ventricle, pulmonary artery and the valves of a dark mahogany color. Left ventricle and auricle distended with soft, tarry-looking clots; heart otherwise healthy. Lungs distended to the full capacity of the chest, their vessels filled with blood, their surfaces uneven, with many shallow depressions, produced by atelectasis. Kidneys.—Corticalsubstance congested. Right kidney much more congested than left. Liver somewhat congested, otherwise normal. Stomach congested in large curvature, and contained about a pint of greenish fluid. From observation of this case, and a study of the disease to which it has led me, I feel confident that hydrophobia is not produced by apprehension and nervous excitement, but rather that it is a specific blood poison, which expends its force upon the nervous system, as indicated by the rapid exhaustion and the so far invariably fatal results. The inability to swallow would naturally lead one to suspect the disease, but the inability to swallow, accompanied by an involuntary contraction of the muscles of deglutition when liquids are presented, together with the spasm produced by a draught of air or a sudden flash of light, are, I think, symptoms sufficient to indicate the nature of the disease. In this case it will be observed that nothing gave much, if any, relief, save chloroform. I think the unfortunate naming of the disease in his presence hastened the necessity for its use, and that it even hastened the patient's death.

In view of the present knowledge of the profession, and of the terrible suffering of hydrophobic patients, I would, if called again to treat it, make early and free use of chloroform, of course endeavoring to keep up the strength of the patient by nourishing injections, stimulants, etc., as best I could. Chloroform would seem to be preferable to ether, because of its more rapid effect and more agreeable smell. Probably the danger from syncope is very little, owing to the general capillary congestion. The use of large doses, hypodermically, of chloral hydrate (gr. 20) and atropine (gr. $\frac{1}{30}$) seemed to have a somewhat sedative effect, yet far less so than chloroform. Finally, from what we know of the disease, it would seem that what is done curatively must be done in anticipation of the acute symptoms, by promptly destroying the poison at its point of entrance, with caustics.—*Med. and Surg. Reporter.*

ALCOHOLISM.

NOT by moral purpose, but inevitably, unavoidably, by the resistless energy of cause and effect, insurance is a factor in the ethical and material advance of man.

An important question is opened, and an emphatic warning given to all persons insured in the Mutual Life, of New York, through a circular dated January 17, 1878, addressed by the trustees of that company to each of its policy holders. It states that of late years there has been an alarming increase in death of insured persons from diseases caused, directly or indirectly, by the use of intoxicating liquors; and the conclusion of the circular is as follows:

"In taking this action, the board of trustees are not to be understood as casting any imputation upon the integrity or the habits of the great body of the insured. It is believed that the membership of this company, as a class, is superior in intelligence, sobriety, and thrift to that of any similar organization in this country, and any intention to enter the arena of debatable questions in religion, morals, or political economy is expressly disavowed; this is purely a matter of business, in which the company relies for its protection on a proper administration of the law of contracts.

"During the past year many policies upon the lives of persons who have become notoriously intemperate have been canceled. It is our determination to pursue this course in future; and if any to whom this circular shall come are conscious that persistence in evil ways is invalidating their legal claims upon the company, we warn them that they may be laying up a legacy of disappointment, instead of the beneficent provision against want which an honorable fulfillment of their engagements will secure."

We doubt whether even the trustees of the Mutual Life, and much less all their insured, *fully* appreciate the wonderfully beneficent effect on life and society which would result from the *literal* keeping by the policy holders of the declaration and agreement that they "did not and would not practice any habit which obviously tended to the shortening of life." That many of the insured have broken and are knowingly breaking this agreement as to spirituous liquors and to other habits, is too certain to need argument.

Knowing, however, the frailty of human nature, and the difficulty of deciding what is and what is not moderation, the company has wisely erred on the side of mercy and liberality. But there is a limit to mercy, while justice to the whole of the insured requires sternness toward a portion who manifest errors injurious to the general interest.

The Mutual Life, of New York, is not alone in its notice of diseases and deteriorating effects occasioned by what is now called Alcoholism, for the report of the Scottish Amicable Life Company for 1876 plainly shows that the experience and intentions of that company agree with those of the Mutual Life. In 1841, the United Kingdom Temperance and General Provident Institution was organized in London, with the avowed understanding of restricting its business entirely to the class of total abstainers. After continuing for some years, it was found that the strictly temperate class was not large enough to reduce the cost of insurance to the expected limits, and the company found that it must either retire or take insurance on persons who use spirituous liquors "with moderation." The latter alternative was accepted, but distinct statistics have been kept of the two classes, and the results down to 1874 published.

In the strictly abstinent division the actual experience fell short of the death-rate expectancy about 39 per cent., while among the temperate users the actual death-rate was also below what was expected, but only one-tenth of one per cent. Although these data are from too limited a field to show a general rule, they are well worthy attention. One fact too little insisted on is that alcoholic liquors are also narcotics, and generally the man who flatters himself he is only "stimulated," is presenting the symptoms of incipient narcosis. Long before the cerebro-spinal system shows signs of succumbing, the nervous system, by unmistakable symptoms of paralysis, or other profound disorders, gives evidence of disease, which, if not quickly corrected, must before long be paid for, and the receipt certified by the diminished dividends of the company in which the deceased is insured.

Mr. Neison, the English actuary, investigated the risks of life companies, with special regard to the effects of alcoholism. His conclusions are embodied in three propositions:

1. When in a given number of risks ten temperate persons die between the ages of 15 and 20 inclusive, eighteen intemperate persons die.

2. When in a given number of risks ten temperate persons die between the ages of 21 and 30 inclusive, fifty-one intemperate persons die.

3. When in a given number of risks ten temperate persons die between the ages of 31 and 40 inclusive, about forty intemperate persons die.

The average expectancy of life he gives thus:

At 20, a temperate person may live 44·2 years; an intemperate person, 15·6 years.

At 30, the respective expectancies are—temperate, 36·5 years; intemperate, 13·8 years.

At 40, temperate, 28·8 years; intemperate, 11·6 years.

A table compiled by W. Marcet, M.D., F.R.S., on this subject, calculated from 695 cases applying to the Westminster Hospital for treatment, cannot be considered as authoritative, because based upon a comparison between "drinkers to such a degree as plainly does or ought to do them injury," and sober persons, all of whom were diseased. He states that two-thirds, or 463, of these patients had diseases caused by indulgence in alcohol, and preventable by abstinence therefrom. A table really showing the comparative liability to disease of thoroughly abstaining and non-abstaining persons should be based upon equal numbers of average men in similar employments and for a definite period.

In the question of the influence of alcohol on health, there should be allowance made for the kind of liquors, and the frequency with which they are imbibed. In France and some other wine-producing countries, it is represented that actual intoxication is far less frequent than in the United States and Great Britain, although in the former countries wine may be so lavishly and constantly used as entirely to replace water as a beverage. There is possibly more danger from the use of absinthe and adulterated wine and brandy in France and other European nations than from any constant use of pure wines.

The alcoholic liquors most largely consumed in the United States are whisky, lager beer, wine, brandy, gin, ale, porter; and California and other native wines, and cider, are more used than formerly, and may possibly produce a favorable change. The question to be considered is this: Is there not a tendency to *increase* the consumption of the beverage in proportion to the *decrease* of the alcohol constituent? There is also no predicting what a revolution may occur in habits through the general introduction of the "bell-punch," which has worked well in Virginia as a register of tax, and is now proposed in the legislatures of several of the larger States. In Virginia, while it has returned a large revenue, the consumption of spirituous liquors has so diminished as to have caused much remark.

Many distinguished physicians and physiologists now affirm that alcohol is not digested, but quickly absorbed, like water, by the veins of the stomach, and then enters the blood; also, that in general it is antagonistic to digestion, and if ever an advantage to the system, when taken in moderation, it must act first through the blood upon the brain and nerves, and these by reflex action on the digestion.*

The experiments of Dr. Bocker, confirmed by Dr. Virchow, prove that "alcohol poisons the blood, arrests the development, as well as hastens the decay of the red corpuscles." Dr. Bocker noticed "the alterations undergone by the blood of habitual alcohol drinkers, *as yet in good health*, namely, a partial loss of power to become red by exposure to the air, in consequence of the loss of vitality in a portion of the blood disks. This loss of vitality manifests itself by the formation of black specks (oil) in the disks (an observation confirmed by Lallemand), and then by their conversion into round, pale globules, which in all cases of disease (*i. e.*, diminished vitality) are found in excess in the blood."†

The eminent French analytical chemist Lecanu found as much as 117 parts of fat in 1,000 parts of a drunkard's blood, the highest estimate of the quantity in health being 8½ parts, while the ordinary quantity is not more than 2 or 3 parts; so that the blood of the drunkard contains *forty times* in excess of the ordinary quantity. This is fatty degeneration of the blood, and lays the foundation of fatty degeneration of all the tissues of every organ of the body, which is the basis, according to Dr. T. K. Chambers, of "three-quarters of the chronic illnesses which the medical man has to treat."

Dr. Aitken, in his Practice of Medicine, says: "When spirituous liquors are taken into the stomach, they tend, in the first place, to coagulate all the albuminous articles of food or fluid with which they come in contact. As an irritant they stimulate the glandular secretions from the mucous membrane, and ultimately lead to permanent congestion of the vessels, and to thickening of the gastric tissues."

Dr. Lankester, F.R.S., in his School Manual of Health, observes: "Even diluted in the form of beer or wine, alcohol is found to act injuriously on the delicate membranes of the stomach and other digestive organs. When taken in larger quantities in any of the diluted forms, it acts most injuriously upon the stomach, liver, brain, heart, and other organs of the body." The organs most affected by alcohol through the stomach are, according to Profs. Lallemand and Perrin, of Paris, "the liver and substance of the brain. If in the blood the accumulation of fatty matter be represented by 1, in the brain it is 1·34, in the liver 1·48." That intemperance is one of the conditions which tend to produce inflammations of the encephalon, meningitis, and cerebritis, almost all writers upon the subject agree. A frequent connection, as cause and effect, is established, both by theory and observation, with habitual intemperance and cases of apoplexy, paralysis, and epilepsy.

Persons acquiring the habit of drinking "moderately," but regularly, generally imbibe from four to six ounces of pure alcohol‡ per day, and the primary effect and first warning

* "When any agent capable of so changing the molecular state of nerve matter as to arrest its function is carried into the blood, it first acts on the nerve-corpuscles. Each change produced in one of these (be it the decomposition of a molecule, or, as is most probable, the isomeric transformation of a molecule) implies a disengagement of molecular motion, that is immediately propagated along the connected nerve-fibers, and excites the parts to which they run. Every nerve-corpuscle being thus quickly acted upon, and emitting successive discharges as the successive molecular transformations are wrought upon it, there results a general exaltation of state, as shown physically by the invigorated pulse and contractions of the muscles, and as shown psychically in the rush of vivid ideas and intensified feelings."—*Herbert Spencer: Synthetic Philosophy, Vol. I., p. 633.*

† The Physiological Action of Alcohol. By Henry Munroe, M.D., F.L.S.

‡ Pure alcohol is about one-fifth lighter than water (sp. gr. ·794); it is highly inflammable, and cannot be frozen at a temperature of 180° below zero, F. Its composition is an organized radical called *ethyl*, combined with the elements of water, and its chemical symbol is therefore $(C_2H_5)HO$—or C_2H_6O. The relative quantity of alcohol in different liquors, as-

is that the stimulus becomes considered a positive requirement of the organic and mental life. The deterioration of tissue is, however, so well resisted in youth, that up to the age of 30 years those habitually drinking may, if they then cease, escape all evil effect. Unfortunately, it is rarely such control is exerted at so early an age; when the habit becomes confirmed, irremediable mischief has already been accomplished.

The array of medical and scientific testimony which can be brought against alcohol, used as a beverage, is very formidable, and yet candor compels the statement that some very respectable authorities maintain that it produces flesh, promotes digestion, and, if not immoderately taken, is, in general, an advantage. We quote, as one example, from a recent work On Food, by H. Letheby, M.B., M.A., Ph.D., Professor of Chemistry in London Hospital, and food analyst for the city of London:

"That alcohol stimulates the action of the nervous system there can be no doubt, and it is equally certain that it increases the respiratory changes, but the effect must not be carried too far. Dr. Parkes found, in his experiments on a young, healthy soldier, that small quantities of alcohol increased the appetite, and roused the action of the heart and capillary vessels; but in larger quantities, as when narcotism began, the effects were distressing. The same was the case with good claret (Haut Brion), ten ounces of which, containing one ounce of pure alcohol, taken in the course of the day, did good, while twice this quantity did harm, by making him feverish and uncomfortable. Dr. Edward Smith is of opinion that * * * alcohol diminishes the functions of the skin, and, by thus lessening the waste of animal heat, has a conservative tendency. Rum, he says, like beer and ale, is a true restorative, as it sustains and increases the vital powers; and the old-fashioned combination of rum and milk is the most powerful restorative with which he is acquainted. Liebig is of opinion that alcohol is oxidized in the system, and is therefore a calorific agent. Dr. Thudichum, in a rather large experiment on the students of his class—33 in number—found that of the 61,730 grains of alcohol in the 44 bottles of wine which they drank at one sitting, only one-half of one per cent. of alcohol escaped unchanged in the urine and perspiration. He therefore believes that alcohol is oxidized in the body, and is a true food. Besides this, the inquiries of Poiseuille have shown that it is a physical as well as a chemical and physiological agent, for it hinders the flow of liquids in narrow tubes (a number of experiments instanced)—and may it not be, then, that the increased action of the heart, and the influence of alcohol, is an effort or struggle to overcome the resistance by the capillaries? The functions of alcohol are manifestly of a complicated nature; in fact, the whole subject is remarkably obscure, and requires the light of science to illuminate it."

The foregoing considerations will prepare us for the investigation of some of the principal diseases produced by alcohol, and their extent, which is the main object of this paper. For the census year ended June 30, 1870, the deaths from all causes in all the United States were 260,673 males and 231,590 females—total 492,263, or 1·12 males to 1 female. The principal diseases and their results were as follows:

	Males	Females.
Pneumonia	22,358	17,654
Fevers of all kinds	18,102	15,366
Encephalitis	7,579	6,122
Paralysis	3,842	3,659
Diseases of liver	3,111	2,192
Apoplexy	2,982	2,244
Bronchitis	2,209	1,842
Meningitis	1,843	1,419
Kidney diseases (except Bright's disease)	1,822	419
Bright's (kidney) disease	1,080	642

In the above census year there were attributed directly to alcohol 1,161 deaths of males and 249 of females. This latter report, any one who has examined the subject knows, is short of the truth. The principal of the numerous authorities we have consulted agree that many cases of diseases caused or aggravated by the use of alcohol, embracing all in the list above given, are either reported wrongly through ignorance or to save the feelings of survivors, the families thus afflicted often moving in the best society.

Dr. H. O. Hitchcock, President of the State Board of Health of Michigan, in an able and exhaustive paper, contributed to the American Public Health Association, in 1875, states that in 1874 he sent 200 circulars to physicians in Michigan, propounding six principal queries—and also sent 200 of the same circulars to prominent physicians in other States. He received many replies, which he thus summarizes:

1. The sicknesses they had at any time observed in adults, and which were due directly to alcohol, varied from 1 to 75 per cent., with an average of 11 per cent.

2. Such sicknesses in adults, within the past year (1873–4), due directly to alcohol, were 1 to 50 per cent., with an average of 13½ per cent.

3. To the question: Does alcohol in your opinion shorten the lives of its victims, and to what degree? affirmative answers, with statements varying from 5 to 50 per cent., and averaging 28 per cent.

4. From 5 to 50 per cent., with average of 21 per cent. of inherited disease, is traceable to alcoholism in parents or ancestors.

5. To the question: What forms of disease in your observation are traceable immediately or remotely to alcohol? the answers indicated, as very frequent, inflammatory diseases of the brain; apoplexy; many forms of paralysis; insanity; imbecility; diseases of the stomach, liver, and kidneys; all diseases dependent upon fatty degeneration; many skin diseases, gout, and rheumatism.

6. The answers were about equally divided as to whether the father or the mother, when addicted to alcoholism, is most likely to transmit disease or enfeebled constitution.

The earliest, most common, and most deceptive disease is often politely called *dyspepsia*, and for it a multitude of anti-bilious pills and effervescing compounds have been invented.

The functions of the skin being vitiated, its appearance is at one moment flushed and perspiring, next cold and clammy; and every other secreting structure is equally disarranged. The nervous structures follow, or, it may be, precede the stomach in the order of derangement, and then results more painful experience. The perverted condition of the membranous covering of the nerves gives rise to pressure within the sheath of the nerve, and to pain as a consequence. To the pain thus excited the term neuralgia, or *tic douloureux*, is often applied; or if the large nerve running down the thigh be the seat of the pain, "sciatica." Such pain commences in nearly every instance at some point where a nerve is inclosed in a bony cavity.

Insomnia is a prevailing phenomenon of these incipient diseases. Sleep is attended with long and embarrassed breathing and uneasy and even convulsive movements of the body, and the apparent sleeper awakes unrefreshed. The effect of alcohol then upon the brain is to maintain the relaxation of the vessels, to keep the brain charged with blood, and so to hold back the natural repose.

Suddenly fatal congestion of lungs frequently overtakes the confirmed alcohol-drinker during severe winters. A prolonged, insidious, and generally fatal effect is called *alcoholic phthisis*, or the consumption of drunkards; and doubtless to this some of the increase within a few years past of the disease called generally "consumption" may be credited.

Dr. B. W. Richardson, F.R.S., of London, says: "In a public hospital to which I acted as physician, I had brought before me in the course of many years 2,000 cases of consumption. I gathered the history of their lives, and found that the leading causes of the malady were, in the great majority of instances, predisposition from hereditary taint, exposure to impure air, want, or other allied causes. The analysis being conducted rigidly, I discovered that there remained thirty-six persons, or nearly 2 per cent., excluded from the above causes, who appeared to suffer purely from the effects of alcohol, and in whom the consumption had been brought into existence by the use of alcohol. The added observations of eleven years, since the above-named observation was recorded in the *Social Science Review* as a new fact in the history of the disease, have only served to prove, in the minds of other men as well as my own, the truth of the record.

"The persons who succumb to this deterioration of structure induced by alcohol are not the exceedingly young, neither are they the old. They are usually between twenty-eight and fifty-five, averaging about forty-eight years. They are persons of whom it is never expected that their death will be from consumption; and they are generally males. I remember being actually taken aback on one occasion on finding, in a man who, from his face, seemed to be in perfect health, complete destruction of his lungs from the encroachments of disease. These persons are probably considered very healthy—men who can endure anything, sit up late at night, run the extreme of amusements, and yet get through a large amount of business. In the ordinary sense they are not drunkards; they may never have been intoxicated, but they partake freely of any and every alcoholic drink, and bear alcohol in a manner remarkable to observers. They are hard drinkers, as distinguished from sots; beer is to them as water, and wine is weak. As a rule, these cannot live in what they consider comfort without a daily excess of alcohol, renewed on emergencies, if there be greater amount of work to be done, less sleep secured, or more life to be lived."

The heart is easily subjected to deterioration by alcoholism, and those who suffer thus, learn the fact so gradually and insidiously as rarely to appreciate it until the evil is far advanced. They are for years conscious of a central failure of power, from slight causes, such as over-exertion, trouble, broken rest, or too long abstinence from food. They feel what they call a "sinking," but they know that wine, or some other stimulant, will at once relieve the sensation. Thus they seek relief, until at last they discover that the remedy fails; the jaded, overworked heart suddenly ceases to beat.

As for liver diseases occasioned by alcohol, and which assume such protean forms, want of space prevents reference to them here. Dr. Peters, as quoted by Dr. Carpenter, says:

"In moderate drinkers the liver was generally found to be somewhat larger than usual, its texture softened, and its outer surface spotted with patches of fatty infiltration. In those more addicted to the use of spirits the liver was still larger; in old drunkards very large, weighing six or eight pounds, often ten or twelve."

Quite analogous are the various degenerations of the kidneys, especially Bright's disease. Of the latter disease Dr. Christison states that more than three-fourths of the cases of it which he attended in Edinburgh, were in persons who were habitual hard drinkers, or in the constant habit of using ardent spirits several times during the day. Dr. Carpenter states that the experience of English hospitals is precisely similar. He also says that gout and rheumatism are often directly or indirectly caused by the use of alcoholics.

Besides positive maladies, there is developed by the habitual use of ardent spirits a marked diminution of power to sustain injuries by disease or accident, and a remarkable *liability* of those who thus indulge to epidemics. It is not possible to account for the fatal termination of many cases of fever and many forms of inflammation, as well as almost every grade of accident and surgical operation, unless the habit of the subject as to the use of alcoholic drinks be considered.

Calculus is a disease which very frequently results from alcoholism, an aggregation of saline particles forming a stone in the bladder. Dr. Richardson states that his observations many years ago, in a part of England where this disease was very prevalent, proved to him that alcoholic indulgence was one of the chief causes. Continued observation since made in the district named, and in other places, has confirmed his views on this point.

Softening of the brain, by deterioration of its cellular structure, or by the interposition of fatty particles, is one of the worst and most frequent results of alcoholism; but no disease in this category is better known than *mania à potu*. About it there are special questions inserted in all applications for life insurance. The victims of this disease are not habitual drunkards or topers, but at sudden intervals they madden themselves with the spirit; they repent, reform, get a new lease of life, and again relapse. In intervals of repentance they are full of remorse and regret; in the intervals of madness they are the terrible members of the community. To physiologists these *maniacs à potu* appear as men under the experiment of alcohol, with certain of their brain centers paralyzed, and with a broken balance of brain power, which can now be characterized and described with much exactness. Though death frequently results from attacks of this disease, it is as a precursor to confirmed insanity that its warnings are most forcible and significant.

Dr. Carpenter, in discussing *delirium tremens*, which is a milder form of *mania à potu*, says: "A slighter form of this disease, marked by tremors of the hands and feet, deficiency of nervous power, and with occasional illusions, will sometimes appear as a consequence of habitual tippling, even without intoxication having been once produced." Marcet calls this a distinct disease, and gives it the name of "chronic alcoholism." Its symptoms depend on a functional disturbance of the nervous system, which may last for weeks, months, or years, even after the habit of excessive drinking has been abandoned.

Dr. Hitchcock, in his admirable paper already mentioned, states that he sent circulars to all the principal insane asylums of the United States, and received many answers. Of the twelve queries propounded on this subject we give the eight principal ones, with the answers:

1. In what percentage of the inmates of your asylum has insanity or epilepsy, in your opinion, been due to alcoholism in the individual?

Answers: Percentages from 6 to 20.

2. What percentage of cases is due to hereditary degeneracy arising from alcoholism in parents or ancestors?

Answers: Most said, "no data;" one said 30 per cent. or more, and one gave 20 as the percentage.

3. Is the former percentage, in your opinion, increasing?

4. Is the latter percentage, in your opinion, increasing?

Answers to Nos. 3 and 4: Mostly "yes;" some replied "don't know," "can't say," or "no data."

5. From alcoholism in which parent is hereditary degeneracy the stronger?

Answers: Mostly "don't know," or "can't say;" a few replied "mother," and a few "father."

6. Does alcoholism, in your opinion, tend directly to shorten life?

Answers: *All* said "yes."

7. To what degree?

Answers ranged from "decidedly" to 25 per cent.

8. Does it tend decidedly to deteriorate and exhaust the race?

Answers: *All* said "yes."

Along with the above replies Dr. Hitchcock received reports of 24,789 cases of insanity from fourteen principal asylums of the United States. In 7 per cent. of all the cases, of both sexes, intemperance was assigned as the cause. In 17,128 of the cases reported, of both sexes, obtained by deducting 7,661 "unknown" or "unassigned," 10 per cent. was considered as the percentage due to alcoholism. Deducting again 2,006, for persons under 20 years of age, left 15,122, of whom 12 per cent. were considered as having become insane through alcoholism. Of all the males (13,214) 13 per cent., of all the females 1½ per cent., were attributed directly to intemperance.

Dr. Charles A. Story, in his Alcohol and its Effects, says that Dr. Morel, of the Salpêtrière and Mareville Hospitals, states there are always in the French hospitals a hopeless number of paralytic and insane persons whose disease is due to no other cause than the abuse of alcoholic liquors. Twenty per cent. was the number of such in 1,000 cases observed.

Dr. Behics, in a report on the physical causes of insanity in France, says that of 8,800 male lunatics and 7,100 female lunatics, 34 per cent. of the former and 6 per cent. of the latter were made insane by intemperance. Motet reports that among 8,797 cases of insanity from physical causes there were 3,045 drunkards.

Dr. Carpenter quotes the report of Dr. Hutchinson, of 1,900 insane patients, during seven years in the Glasgow lunatic asylum, in which nearly 20 per cent. are set down as caused by intemperance. "In one asylum in the east of London the percentage is 41." Dr. Macnish states that of 286 lunatics at that time in the Richmond Hospital, Dublin, one-half owed their madness to drinking.

A fair conclusion appears to be that alcohol has a function to fill in relation to the human organism, but that its use is not controllable nor physiologically known. That there can be a use of alcohol which will prolong life is possible, even probable, but to assert such use is to assert a power over the human system which must be freed from abuse by minute and strict regulation. While, medically, it is a question of drops, nutritively it is not a question of gills. That liquids with the minimum proportion of alcohol are the safest is probable, but if a man drinks three times more of an 8 per cent. alcoholic liquid than of a 24 per cent. one, he simply adds to the alcoholic peril the danger of other constituents. And really, whether whisky, wine, or beer is the least disastrous depends upon the personal constitution. The thought is growing up among the laymen that the palate, the stomach, and the body know better the corporeal needs than does the doctor; there is a measure of truth in this—it is fundamentally true. Yet a habit and a craving formed by misdirection is not a natural demand of the system, but a perversion of it; not the instinct of the organism, but its insanity.

Liebig having stated some years since that a *farinaceous diet* was favorable to temperance, Charles Napier, an English scientist, has recently been experimenting in regard to it, and announces that it is true, and gives some remarkable instances of reform through it. If we inquire the cause of a vegetarian's alleged disinclination to alcoholic liquors, we find that the carbonaceous starch contained in maccaroni, beans, or like oleaginous ailment, appears to render unnecessary, and therefore repulsive, carbon in an alcoholic form.

It would, perhaps, be a happy innovation for society if, after the lapse of 2,400 years, it would now become fashionable for those inclined toward alcohol beyond their capacity to request, as the youthful Daniel did, with such good result: "Prove thy servants, and let them give us pulse to eat and water to drink!"—*American Exchange and Review.*

cording to Brande, is about as follows: Rum, whisky, brandy, and gin contain from 53 to 57 per cent.; port wine, 22; champagne, 12; cider, 5 to 9, and beer 4 to 6 per cent. Neumann's analyses make beer to contain 5 to 10·90 per cent. of alcohol.

SPEECH FOR THE DUMB.

ON the invitation of Miss Dudin Brown, an influential assembly met at the Buckingham Palace Hotel, London, when very interesting information was given as to the teaching of the deaf by articulation, with a view to promote the interests of the Society for Training Teachers on that system and for its diffusion in the United Kingdom. Miss Hull was present with two of her pupils to prove the reality of the work. The Bishop of Sydney was in the chair, and among the guests were Professor Alexander Graham Bell (inventor of the telephone), the Rev. Canon Fleming, the Rev. Marcus Rainford (of Belgrave Chapel), Lady Smith, the Hon. Miss Hubbard, Colonel Battersby, Captain Lowe, Admiral Gardner, Miss Hargreaves Brown, the Misses Deacon, Mrs. Evelyn, Mrs. Turner, Mrs. Lumsden, Mrs. Erichsen, Mrs. Lea Wilson, Mrs. James Rowland, Dr. David Buxton and Mr. B. St. John Ackers, acting and honorary secretaries respectively of the society, and Mr. Arthur A. Kinsey, Principal of its College.

Mr. B. St. John Ackers hoped that before the lapse of a

twelvemonth the society would be able to send a teacher out to Sydney. There were, he said, no fewer than 30,000 deaf persons in England, most of whom were dumb as well, and 10,000 of these, sad to say, received no education at all. The only reason he could conceive why the blind met with so much more compassion than this unfortunate class was that the affliction of the former was more palpable. In past centuries it was the common belief that those called deaf and dumb were idiots, or worse, and too much of this feeling still survived. The sufferers were thought to be hardly human, and not so very long ago they used to be chained up. The misery of this class and the wrong done them had been forcibly brought home to himself and to others in that room by family experiences. It was this which had led him to travel not only in European countries, but in America also, that he might get light upon the subject. The system which he had seen in operation in Germany for restoring the deaf to their proper places in society was incomparably the best. But it was not till the holding last summer of the "Conference of Head Masters of Institutions and of other Workers for the Education of the Deaf and Dumb," under the auspices of the Social Science Association, that this had come to be generally acknowledged. The German method of teaching articulation possessed many advantages, as against the French system, which taught by signs and the finger language, although he thought this latter might be still useful in the cases of those pupils whose eyesight was defective or whose mental faculties were impaired. He gave the preference to the German for various reasons. Under it the deaf were no longer dumb. It taught the pupils to speak in their mother tongue. It retained and utilized the speech of those who had lost their hearing after having learned to speak, and enabled them to understand the speech of others. It lessened and almost removed the isolation felt so terribly by the poor deaf and dumb. It dispelled the notion so prevalent, even among educated people, that congenital deafness and weakness of intellect are allied. It even enabled the deaf to enjoy and profit by high class literature. It had a tendency, moreover, to decrease congenital deafness; it improved the health, mental and physical, of the deaf; and it was especially valuable as securing to all the deaf educated by it religious instruction and consolation. (Applause.) Hence he had felt it to be his duty to do all in his power to spread the system.

Miss Hull then, upon the call of the chairman, dictated to her pupils, youths of 10 and 12 years of age respectively, a child's story, entitled, "Loving Ministry." They knew nothing of it beforehand. Miss Hull read portions to her two pupils alternately, and but for a stumble or two at a trisyllable or other hard word their articulation, although still dead-deaf, was perfectly distinct. One pupil then read a few sentences from the same story to the other, who wrote them at his dictation so legibly that the Bishop of Sydney afterward expressed the wish that all clergymen in his diocese and in some others were in the habit of writing as legibly.

Prof. Alex. Graham Bell, the next speaker, said that it was a common idea that the vocal organs of the so-called deaf and dumb were deficient, and he had even heard this opinion from medical men, who should have known better. He had himself examined the vocal organs of over 500 pupils in American institutions for the deaf and dumb without finding any defect that is not also to be found in the mouths of those not deaf. To illustrate the purely mechanical nature of speech he spoke of having received from across the Atlantic a few days ago one of Mr. Edison's phonographs, and after placing the machine on a table in his Liverpool hotel, and turning a handle, his friends, who had brought the instrument, were addressed by name, and were thus greeted, "Once for all, I wish you a pleasant voyage and a happy time in England." These words, he said, had been spoken into the phonograph at starting, and rendered faithfully at the other shore of the ocean 3,000 miles off. (Applause.) Professor Bell next traced the development of a deaf child growing up destitute of instruction. To bring such a child into our own condition three things were indispensable. His mental darkness must be dispelled; his organs of speech must be educated; lastly, his eye must be trained to take the place of his dead ear, so that he may come to understand the utterances of those who speak to him. A contrast was drawn between the sign system, including dactylology, and the method by articulation and lip-reading, the former being known as the French and the other as the German. It had been within his own observation that the sign system, by giving to the deaf a language different from that of others, tended to segregate them from the rest of the community, the result being that they intermarried among themselves, thus propagating their physical defect. The tendencies were the reverse under the other system. All must be agreed upon the desirability of linking them with the rest of mankind, so that they may talk with their fellows by word of mouth. The only question was as to the possibility of getting the deaf to hear and the dumb to speak, and upon this question the experiments they had just witnessed spoke for themselves. He remarked upon the marvelousness of hearing with the eye. What they had beheld was surely enough to banish from their minds the too prevalent notion that those born deaf are naturally less intelligent than others. In America that notion was not so common as here. Indeed, the Americans recognized the fact that those thus afflicted are capable of the very highest mental culture, and Congress had even established a special university for the deaf, although the people of the United States were only now awakening to the conviction that the mouths of the deaf were as capable of instruction as their minds. In the town of Belleville, in Canada, he had himself met two deaf gentlemen, who were unfortunately dumb also, who were in good practice as lawyers. Indeed, clients preferred this pair of deaf and dumb lawyers, especially in any private affair. (Laughter.) Professor Bell was proud to say these two gentlemen had been trained in his own native country, Scotland, by the late Dr. Anderson, of Glasgow. He was sorry, however, that the two lawyers had not been taught to articulate, even though it might have spoiled their practice. He hoped all present would support such institutions as the Training College for Teachers of the Deaf on the German system, and so hasten the time when the deaf should no longer be dumb nor the dumb deaf. (Applause.)—*London Times.*

THE FOUNDER OF MODERN HISTOLOGY.

IN the course of a few weeks a festival will be held in the city of Liége, to celebrate the 40th year of the professorship of Theodore Schwann, the author of the cell theory. The founder of modern histology is actually, at this moment, alive, and teaching as Professor of Physiology in the Belgian University. The committee charged with the management of the celebration desire the co-operation of scientific bodies and of individuals in this country. It is requested that letters intended to be read at the celebration may be forwarded either direct to the secretary, Professor Edouard van Beneden, Liége, or to Mr. Ray Lankester, Exeter College, Oxford.—*Nature.*

DUST AS AN EXPLOSIVE.

SINCE ordinary fire consists in the combination of the combustible body with the oxygen of the air, it is evident that in general the rapidity of the burning will be greatly increased by the degree of comminution of the combustible. Other things being equal, the finer the state of division, the more energetic the combustion. The reasons for this are twofold, viz., first, the cohesion of the particles being partly overcome by the fine state of division, and second, the extended surface thus given to the combustible favoring its rapid union with the oxygen of the air. So powerful are these influences in increasing combustion, that many substances which in bulk are either relatively non-combustible, or are ignited only with considerable difficulty, are, when in a fine state of division, so very readily inflammable as to ignite spontaneously—using this word in the sense of combustion without the intervention of direct human agency. In some instances this spontaneous ignition is so rapid as to cause an explosion. This subject, from its importance, has been alluded to in various issues of the *Review*, but we desire to call again the attention of our readers to some additional phases of the phenomena, with a very brief recapitulation of a few of the more important facts of the case.

As an example of lessened cohesion influencing combustion, we may cite the case of iron. In large masses iron burns or rusts but slowly—this rusting being a real burning, viz., a combination of the iron with the oxygen of the air. Iron filings burn with brilliant scintillations when dropped into a flame; iron in a finer state of division, as iron reduced from the oxide by hydrogen, can be ignited by a match like tinder. In a still finer state of division, obtained by the decomposition of the oxalate by heat, the iron is spontaneously inflammable when poured through the air.

Phosphorus in masses oxidizes slowly in the air. Dissolved in carbon bisulphide, the subsequent evaporation of the solvent leaves the phosphorus in such a finely divided state as to render it spontaneously inflammable.

The fine condition of comminution of numerous materials known as dust affords various examples of the influence of this condition of matter on the rapidity of its combustion.

Flour dust, a name given to the very fine material which collects in various parts of flour mills during the grinding of the wheat, has been found in a number of instances to possess the power of explosively igniting on the approach of a lighted candle, or perhaps by the passage through air charged therewith of an electric spark produced by the friction of a belt on a pulley.

Explosions from similar causes have been known to occur in breweries. It is customary to raise the crushed malt from one floor to another by means of a series of cups revolving on a leather band. The casing which incloses the band is, of course, during the operation filled with floating dust, as is evident on opening any door leading into such casing, when a stream of malt dust is shot out into the room. Now it has occurred, in a case cited in *Nature* for December 13, 1877, that in a large English brewery—that of the Messrs. Alsopp, at Burton-on-Trent—a workman, provided with an undefended light, shortly after the starting of some new works on attempting to make an examination of the working of the leather band, was met, on the opening of a door leading into the casing, with an explosion sufficiently powerful to throw the band out of gear.*

The publication of the above called forth a statement from a brewer, who asserts that no less than three explosions have occurred at his establishment from similar causes; so that it would appear that explosions from this cause are by no means uncommon. In one of these explosions the combustion was very sudden, and the flash quite sufficient to singe the whiskers of the operative causing it, while the force of the explosion was powerful enough to blow open the door of the engine room, although the only communication between it and the place where the explosion occurred was a small hole through which the shafting worked. The writer states that since he has taken the precaution of having a number of holes bored through the wooden box to permit the free entrance of air, and so prevent the accumulation of the dust, no explosions have occurred.

From the foregoing instances it will be evident that no inspection of the smut-boxes of flour mills, or of places where fine dust from crushed grain is thoroughly mingled with air, should ever be attempted with unprotected lights. Safety-lamps, of the same general type as those employed in collieries, alone should be used.

Carbon, as is well known, is one of the most valuable of our fuels, from the energy of its combination with oxygen. We might suppose, therefore, that when this substance is finely comminuted, it would, like those already mentioned, increase the power of rapid combination We shall find, on examination, that the facts of the case are in full accord with the supposition.

The power which charcoal possesses of condensing various gases within its pores is well known. This condensation is, of course, like any other case of condensation, attended with the evolution of heat. If the charcoal be in a finely divided state, it will, if recently made, absorb oxygen so rapidly as to become spontaneously ignited. In the manufacture of charcoal for gunpowder, the charcoal is prepared by heating some dense hard wood, like dogwood or willow, in closed iron cylinders. After cooling, it is then ground in mills, preparatory to being mixed with the sulphur and the niter. Here, then, we have freshly prepared charcoal in a finely divided state, and it is a well substantiated fact that this material frequently ignites spontaneously on being removed from the mills. In some instances this ignition has been known to take place several days after the grinding. This, however, is not the only instance in which charcoal in the condition of fine dust has been known to ignite spontaneously. Lampblack is one of the finest states in which carbon can be readily obtained in large quantities, and in this fine state of division, as might be expected, its ease of spontaneous ignition is very greatly increased. We have noted in back numbers of the *Review* several instances in which fires have occurred in manufactories of lampblack, by the mere exposure of freshly prepared lampblack to air. Moisture appears to be especially active in determining the combustion. A mere drop of water, as of perspiration, or a small quantity of grease, will start a fire in a mass of the material which will spread with great rapidity. The simple condensation of the moisture of the room on the window panes requires, it is said, to be carefully looked after, lest, by igniting the dust settling thereon, it should cause a destructive conflagration.

One of the most interesting cases of the ready combustion of carbon in a state of fine division is perhaps the influence it exerts, when in the condition of fine coal dust, in the destructive explosions of the gases in coal mines. From the freshly cut surfaces of the coal, and from fissures in the veins of the mine, gas is constantly being evolved in large or small quantities, and much of this gas forms, when mixed in certain proportions with air, a highly explosive mixture, which is ignited at once by contact with an uncovered flame. For this reason, as is well known, the necessity exists for the use of the safety-lamp of Davy, or any of its many equivalents.

The frequency of colliery explosions of late, and the awful loss of life which almost invariably attends them, have rendered it very evident that either the safety-lamps are poorly constructed, or the police regulations preventing the operatives from uncovering their lamps, for the purpose of trimming the wicks or refilling them, poorly enforced, both of which appear quite possible. Apart, however, from these evident sources of danger, explosions may occur with the best of lamps and the most perfect police regulations, since it has been proved that the safety-lamps are inoperative under the following circumstances:

1. When the atmosphere in which the miner may be at work is so filled with the mixed gases that they are observed to burn inside the gauze covering, the locality should be at once abandoned, and the air removed by ventilation. If the lamp be kept burning for any time in such an atmosphere, an explosion is almost sure to follow from the ignition of the mixed gases outside the wire gauze. In this connection we note a recent English invention, in which the lamp is so constructed that the burning of the mixed gases within the gauze produces a musical note, which warns the miner of his danger.

2. If the explosive gases are moving at the rate of eight or nine feet per second, the flame will soon ignite the gases outside of the gauze, as was found by the experiments of Mr. Wood in 1870, and corroborated in 1876 by a committee of engineers appointed for the purpose.

3. If the lamp be burning in the explosive gases, with the passage through them of an intense sound—such, for example, as that produced by the explosion of a blast—the flame is communicated to the air outside the gauze. These points were established by observation of W. Galloway in 1872 and 1873, from whom we condense these facts.

4. A very sudden escape of large quantities of explosive gas from the exposure of a large fissure, or the sudden failure of the ventilating current, may produce such a condition of the atmosphere as would render the escape of the operatives impossible, even were they all provided with safety-lamps.

It has been well known for a long time past that it is not alone to mixtures of the issuing gases with air that the explosions in collieries are to be ascribed. Finely divided coal in the shape of dust is always present to a greater or less extent in the air of a mine, or, if not present in sufficient quantity, is sure to be produced by the shock of the explosion. This dust furnishes a material which gives the fire power to spread from gallery to gallery, should the mixed gases themselves be insufficient in quantity to permit such a spread. Indeed, it would appear that coal dust itself, when mixed in certain proportions with air, renders the air explosive without the presence of any of the gases usually evolved in coal mines; and there can be no doubt that the presence of coal dust renders mixtures of coal-mine gas and air explosive that would otherwise be quite harmless.

Since the report of Lyell and Faraday, in 1844, to the Home Secretary, on the explosion at the Haswell colliery, the influence of the presence of fine coal dust in the air of a mine on the violence of the explosion has been well understood. This report, an abstract from which we quote from an article on the subject by W. Galloway, contains, among other interesting statements, the following, viz.: "In considering the extent of the fire at the moment of the explosion, it is not to be supposed that the fire-damp is its only fuel; the coal dust, swept by the rush of the wind and flame from the floor, roof, and walls of the works, would instantly take fire and burn, if there were oxygen enough in the air to support the combustion; and we found dust hanging to the face of the pillars, props, and walls in the direction of and on the side toward the explosion, increasing greatly to a certain distance as we neared the place of ignition. This deposit was in some places half an inch and in others almost an inch thick. It was packed together in a friable coked state. When examined by the glass, it presented the fused, rounded form of burnt coal dust, and when examined chemically, and compared with coal itself reduced to powder, was found deprived of the greater portion of the bitumen, and in some cases was nearly destitute of it."

Since it is hardly conceivable that the air of the galleries where coal is being mined can be entirely free from dust, it will be evident that any plan which reduces the amount of this dust must, other things being equal, decrease the liability to explosion. Mr. Galloway points out that in damp mines explosions are very rare, a fact he ascribes to the comparatively small quantities of dust present in the air, while in very dry mines explosions are frequent. In several hundred collieries with which he is acquainted, he asserts that he has never known a dangerous explosion to occur in damp ones, while, on the contrary, in very dry mines a considerable number of very serious explosions have occurred, and often several at different points in the same mine.—*American Exchange and Review.*

* A more recent correspondent of *Nature* says: "There have been three explosions of malt dust in our mill within four years, *not due to any carelessness* in allowing a flame to approach the impalpable dust, but igniting by a spark from a piece of flint passing through the steel rollers, or from excessive friction in some part of the wood fittings. Such explosions are not uncommon."

THE AMERICAN PATENT SYSTEM.

AT a meeting of the French Society of Arts (Société d'Encouragement pour l'Industrie) M. Laboulaye declared that the American system of patents was the basis of the rapid industrial progress of the United States, and that England, France, and Germany must imitate it if they wished to hold their own against transatlantic competition. (M. Laboulaye is right; we must encourage invention or fall into the background.) At the same meeting it was proposed to establish a system of international patent-right. The idea, says *The Chemical Review*, almost presupposes universal free trade, of which there is certainly at the present day no immediate prospect. We should think it an immense boon if Imperial patents, covering the whole of Her Majesty's dominions, could be established. To protect an invention at present throughout the British Empire costs about £1,100.

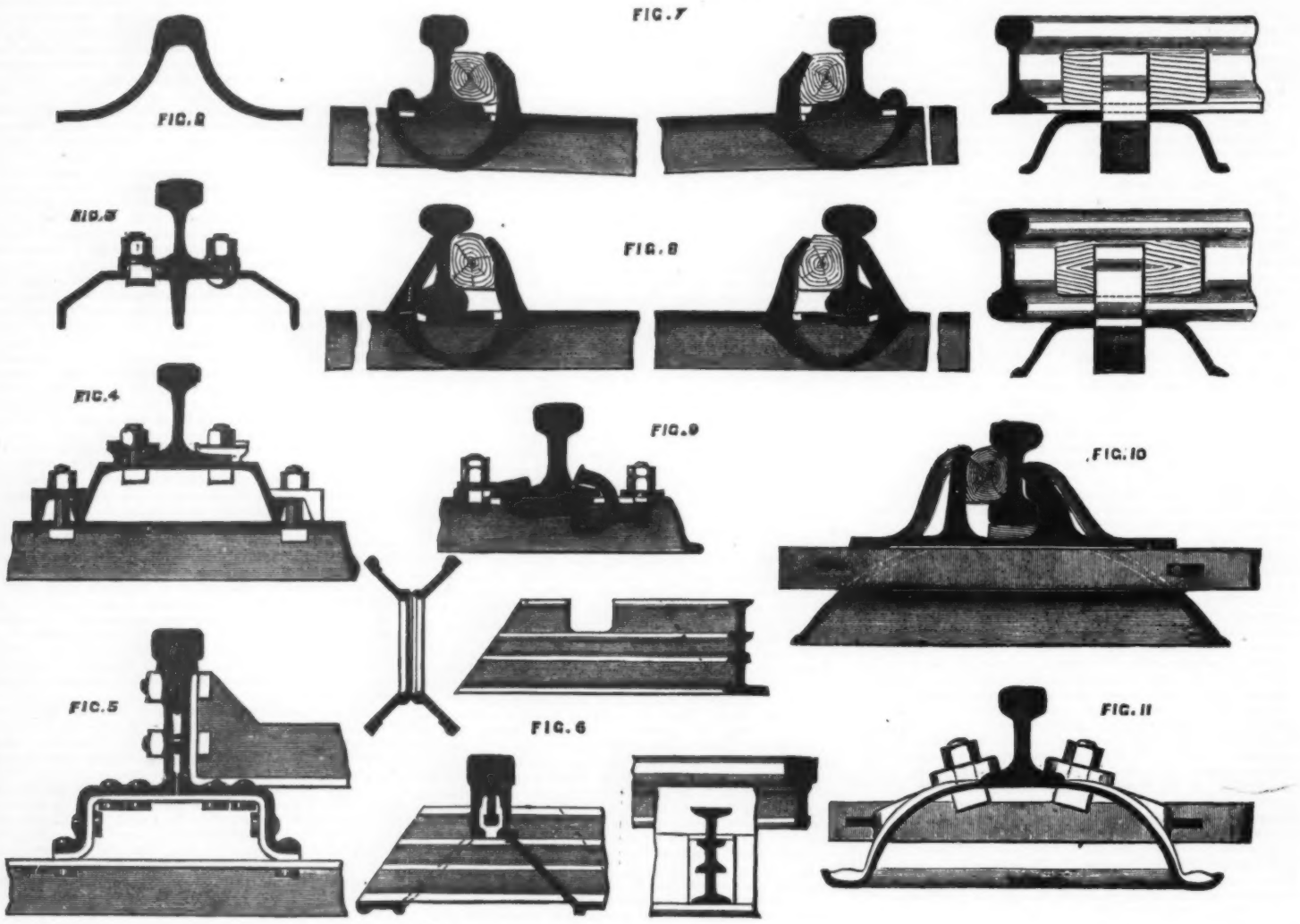
IRON RAILWAY TIES AND SLEEPERS.

By CHARLES WOOD.

THE double-headed rail is the one which, a few years ago, almost universally found favor in England, because when one head was worn out it could be turned, but English engineers seem to have lost entire confidence in this turning property, and the most important railways in the kingdom are now laid with what are known as bull-headed rails—as shown at Fig. 1. Having thus departed from the equal or double-headed rail, I am unable to appreciate the form of bull-heads, unless it be that the chair and wooden keys about 5 millions, on account of many railways being laid with cast and wrought iron sleepers, so that we may fairly take 40 millions as being the yearly destruction now going on. These contain on an average about 2½ cubic feet of timber in each sleeper, or about 100 millions of cubic feet, and if they are estimated at the moderate sum of 1s. 3d. per cubic foot, we arrive at the enormous sum of £6,250,000 annually spent on this one item of railway economy alone. Taking these figures in conjunction with the constant increase of new railways, it seems to me only natural to look forward to a great increase in the price of timber in the course of a very few years. I hope to be able to prove, in the following remarks, that by the adoption of wrought iron or steel in the place of wood, the annual saving, inclusive of transport, relaying, and other expenses, would be over £3,001,000 per annum; while for a few years, if this change actually did take place, the demand upon our rolling mills would be equal to about 3 millions of tons per year. But suppose that only 10 per cent. of this quantity were employed, we have still sufficient to set the whole of our idle mills and destitute hands on full work again for years. I should feel glad if my remarks in any way conduce to so desirable an end by calling the attention of railway companies to these very important points.

Before proceeding with the question of wrought-iron sleepers, I will endeavor to place before you a few facts as to the durability and cost of wooden railway sleepers, as upon these I have based many of my calculations. Mr. Harrison, the well-known engineer of the Northeastern Railway, has said that on the main line creosoted sleepers have stood for twenty years, and are then fit for many years' service in sidings and colliery roads. I have since ascertained that these sleepers were of Scotch fir, a timber well known for its durability, but at the same time a material—of the sizes required—which cannot now be purchased except at very high prices, the present price in the market being, for a sleeper 9 ft. by 10 ins. by 5 ins., about 6s., while the same size in Baltic timber will cost above 3s. 10d. each. I am informed by the chief inspector of the Stockton and Darlington Railway that the ordinary Baltic sleepers now used will not last more than eight to ten years, even when well creosoted, and I can give plenty of other evidence to the same effect; while Mr. Gilkes assures me that the creosoted sleepers laid on the approaches of either end of the Tay Bridge had all to be replaced after five years and three-quarters service. I have also evidence to show that in tropical climates wooden sleepers will not average so much as this, even when carefully pickled; and if exposed to the climate, either at the depots or on the line before being finally covered up, or from the ballast wearing or blowing away, the timber cracks, the water then gets into the openings, and they split and decay rapidly. It is no uncommon thing for many to become quite useless after five or six years from the time of their shipment, while the hard wood native sleepers of India will not stand so much as this. Most of the wooden sleepers now being employed in India are shipped from England.

The various systems of iron sleepers for permanent ways may in a few words be classified as under:—Firstly, the bowl, pot, or oval sleeper, whether in wrought or cast iron or steel, these being all connected with tie-bars; secondly, the longitudinal wrought-iron sleeper; thirdly, the wrought-iron transverse or cross sleeper. With regard to the cast, wrought iron, or steel bowl, or dish sleepers laid down in India or elsewhere, I do not for one moment wish to depreciate the valuable services of their inventors. These sleepers have done good work for many years, but they have their defects. I have taken the liberty to draw many of the following remarks from a most interesting paper read last year before the Institution of Engineers and Shipbuilders at Glasgow, by Mr. Ernest Benedict, C.E., many years resident engineer upon the Goulunds Extension of the Eastern Bengal Railways. There seems to be little doubt as to the durability of the cast-iron bowls with tie-rods, on the Madras Railway. The cost of maintenance, as compared with



IRON RAILWAY TIES AND SLEEPERS.

which engineers have been so long accustomed to have given such great satisfaction that they do not like to abandon them. When we take into account the angle of stability of the flat-bottom rails, as also shown at Fig 2, in comparison with that of the double-head, the lightness of weight, and great area of bearing surface in the flat foot, it must be admitted that it offers many advantages; and the very fact that many thousands of miles of railway are laid with this rail without a chair to hold it down, speaks much in its favor.

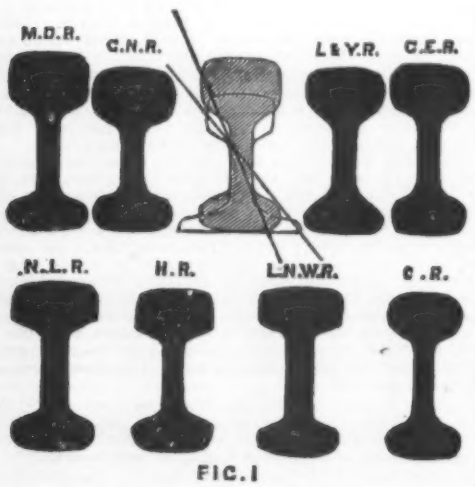


FIG. 1

Give it, then, a good fastening, and it will give yet greater satisfaction, and will, in my opinion, in its turn replace the bull-head. Turning now to the question of permanent ways, the Vienna report, before mentioned, says that "of the 250 millions of sleepers, forming the timber portion of the railways of the world—in 1871—about 36 millions become useless every year," but this seems to be based upon a life of only six years. Taking the life at an average of eight years, and allowing for the large increase of mileage since that date, we find that about 45 millions of sleepers will be the annual requirements. We must, however, make a deduction of

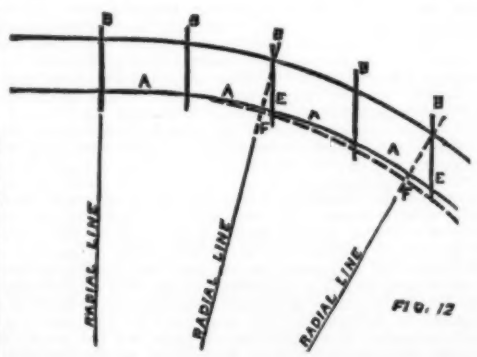


FIG. 12

jungle wood, was found in five years to be as 3 to 1 in favor of the metal sleepers, or as 1,500 to 500. The disadvantages of cast-iron bowls in foreign countries, when used in the original construction of most lines, are their great prime cost, and the time it takes for the saving in maintenance to cover the interest on the extra outlay incurred. The breakages in transit must also enhance the prime cost. Their weight is greater than that of wooden ones, and thus has a serious effect on the cost of inland carriage over country roads, or over no roads at all. Cast-iron bowls were laid on the line between Middlesbrough and Guisbrough on one line of rails, and have been down twenty-four years, so that as far as durability is concerned they have answered pretty well. The great trouble has been through the constant settling in the ballast, chiefly, I am informed, from the want of bearing surface; and I am told by those in charge that the labor for keeping the line level was just double that of the ordinary sleeper road laid side by side on the same line. Mr. Cudworth, the engineer of this line, has informed me that they also cause trouble by canting, and thus twisting the rail. When a length was uncovered the rails were twisted all ways and the tie-bars bent; where the curves were heavy the tie-bars were rusted nearly through in the center from the constant springing between the rails. But the chief fault, which is the same in all classes of iron bowls, is that a tie-bar once put in can never be removed; they almost immediately become corroded fast in the chairs. So much is this the case that if a single chair or tie-bar becomes

useless, it necessitates the destruction of the pair of bowls, tie-bars, keys, and cottars. This is a serious consideration. It will be also noticed that if the rails get out of gauge they could not be adjusted. But I would have it observed that, after twenty-four years' service, the corrosion of both the tie-bars and bowls has been but little; and that the tie-bars, except in the middle or center between the rails, are little the worse. These bowls were chiefly laid in breeze ballast, and Mr. Cudworth and many others inform me that, so far as elasticity of sleepers is concerned, they never could tell when they were running on the cast-iron bowls or on the wooden sleepers. This seems then to set at rest two important points, viz., corrosion and elasticity.

With regard to the constant attention necessary where bowls are laid down in India, Mr. Benedict says that it requires a European inspector to trolly over his length of twenty-one miles every day, and that he, as chief, did the same thing once a month over his whole section. This, with five gangs of platelayers to every eight miles of single road, seems to me a considerable drawback to the bowl sleeper system. It is also mentioned as an objection that when a train is passing over a line laid with the bowl sleeper during the hot weather the dust is very great, each bowl sending a puff of dust up through the packing hole on the top. This blows directly upon the axles, and causes considerable damage to the rolling stock. In India, where the transport is so heavy upon the cast-iron bowl, to have to destroy a pair of bowls, tie-bars, keys, and cottars, through a slight defect in either one or the other, becomes an item of serious importance. Moreover, the breakage and weight in inland transit by bandy carts is also a matter of consideration.

With all these disadvantages, however, Mr. Benedict shows us, as before mentioned, that the cost for maintenance of sleepers is in favor of cast-iron bowls over wooden ones, as 3 to 1, and he puts their life down at fifty years.

The longitudinal sleeper system comes next under review, but as this system has not found favor in this country, although it has often been tried, I shall confine my remarks to the system introduced by Mr. Hilf, the chief engineer on the Austrian railways, and to the application of this system in general to tropical climates and to countries where there is a heavy rainfall. We are informed by Mr. C. Muller, of Middlesbrough, that Hilf has 1,000 miles of railway upon his plan laid down on the Continent. The section is shown in the cut, Fig. 3. This is a sufficient guarantee that the system is in practical use, and when once laid down and bolted up properly to gauge, it no doubt makes a very good road. But on looking at the section we shall see the impossibility of curving these sleepers along with the rails when going round curves. It therefore happens that sleepers have to go in a series of straight pieces, and that the rail lies in a curved form upon the top. We are informed, also, that the sleeper and ties have to be submitted to differential punched holes, according as they are placed on curves, or otherwise necessitating the use of eight different graduated gauges. This makes it necessary to have constantly in stock no fewer than thirty-three different types, so as to allow of prompt repairs. The consequence is that experienced workmen only are employed, and these must have shops and tools at their command, and any mistake in forwarding a wrong section may have serious consequences in case of a breakdown. We are also told that it requires nearly twenty separate pieces of iron per yard of single line, without counting the rails. With all these complications and defects I would ask: Is it possible that this system can find favor with engineers, more especially in India, where men cannot be educated to the difference of plan of laying down a line? Knowing how necessary simplicity is, I, personally, would not like to undertake it. Longitudinal sleepers are not so able to suit tropical climates, where the rain often falls at the rate of 1 in. in the hour, and thus continues often for hours together; the total fall during a monsoon commonly reaches the enormous quantity of 5 ft. in depth. I have often seen newly-made roads and embankments, of no mean height, greatly damaged with a single night's fall of rain. It will be at once apparent to practical engineers that in laying a deep longitudinal sleeper, with the rail upon the top, upon a sharp curve or an incline, and with the outside rail elevated to the curve, the water would be thrown upon the inside sleeper, and a scouring action at once commence, completely undermining the inside rail, and thus rendering the traveling in such weather extremely dangerous—an hour or two in a rocky, mountainous country being quite sufficient to cause this effect. The water upon the cross-sleeper system has quite a different effect. The water courses over the tops of the sleepers, each sleeper checking or retaining the ballast, and the water finding full vent under the rails between each sleeper. The ballast thus remains intact under the permanent way. In this respect the pot or bowl system has considerable advantage over the longitudinal. This fact will be fully appreciated by all engineers acquainted with India or other countries where the rainfall is heavy.

We will next pass on to that now almost universally-adopted system, the cross-sleeper, and I think I may with confidence state that, go where we will, engineers always come back to this as the safest and most reliable. How many hundreds of schemes have been brought out to be replaced by the cross-sleeper? And when we consider the question in a mechanical point of view, what other judgment can we come to? We have, for example, an enormous weight resting upon two rails, each rail being placed, perhaps, on the two outside edges of an embankment, with a load rolling and vibrating, always knocking or trying to force the two rails apart. Any poor mechanic, if asked how to keep these two rails together, and to distribute the weight of the train over the top of the embankment, would tell you to put a girder between the two rails, and fasten the rails down upon it; the rails and sleepers at once become girders, and we have thus the weight of the train distributed equally over the top of the embankment, while, by the longitudinal system, the weight is only on the rails, which being without proper support, on soft soil, settle or get out of gauge. The pot or bowl system has many advantages over the longitudinal sleeper, but I have never yet conversed with an engineer acquainted with the two systems who has not admitted that in every respect both systems are inferior to the wooden cross-sleeper as usually employed. There cannot, therefore, be a doubt that the cross-sleeper is the proper mechanical form for a permanent way; but timber is not always to be obtained, except at a heavy cost, or, in tropical climates, for the reasons already explained, cannot be economically employed. We therefore come at once to the idea that we want a substitute for the wooden cross-sleeper. Cast iron has two great advantages. Firstly, it can advantageously be made into any convenient form; and, secondly, it is the cheapest article in metal. But there are two equally important objections to its use. These are its great weight and its brittleness. We thus come to consider the desirability of employing wrought iron or steel.

Figs. 7 and 8 represent designs for a new wrought-iron sleeper and clip-chairs, adapted for both flat-footed and double-headed rails, which I have lately brought out, and which, without exception, is the most simple yet constructed. It consists of an inverted trough, not unlike the old half-round wooden sleeper with the round side upward. Through square holes punched in this trough is slipped from the under side a clip-chair of rolled wrought iron or cast steel. This clip-chair is of a horseshoe shape, one side forming a hook, not unlike the head of a spike for fastening flat-bottomed rails upon wooden sleepers, about 2½ ins. wide, and the other side is like one jaw of an ordinary railway chair for taking a wooden railway key. It will be readily seen that the wooden railway key at once fastens the rail tightly upon the sleeper as well as holds the clip-chair in its place. It will be noticed that the chair is to a certain extent expansive, the wooden key taking up any little irregularity in width of jaw, and forcing always the rail accurately to the gauge of the way, which cannot possibly vary. A sleeper, with these two clip-chairs, and the two wooden railway keys, making in all five pieces, form this most simple yet perfect tie between two rails. The advantages are obvious. Any uneducated hand can at once lay the rails perfect to gauge, because he cannot put it wrongly together. There are no bolts, nuts, washers, cottars, split-pins, or gibs, tie-bars, spikes, trenails, or rivets; no trusting to your men to keep the gauge right; no complication of hexagonal washers, or differential pitch of holes to get the gauge right, or, as it would be with niggers, to get the gauge wrong. There is the same area of bearing surface as in a wooden sleeper, while compared with the bowl or longitudinal sleeper there is 30 per cent. more. It is easily packed, and is equally easily lifted as the wooden sleeper; when leveling up the road, a rail can be quickly taken out and put in again, or, if necessary, by knocking out two or three keys, and by springing in the rail, a single chair can be taken out without disturbing any of the sleepers. In the hands of strange men, therefore, a new road can be put down very rapidly, as everything being made to template requires simply putting together, the only tool required being a hammer to drive up the wooden key. These sleepers, if in iron, would weigh about 66 lbs. each, or, if in steel, about 50 lbs. each, for the 3 ft. 6 in. gauge, or about 12 per cent. lighter than a creosoted Baltic sleeper. They pack one inside the other; they will not break in transit, and exposure to the sun has not the slightest effect upon them, except, perhaps, a trifle in the length, while their value, as I shall presently show, after from forty to fifty years' wear, will be nearly half their original cost, having outlived between three and four wooden ones, which, in their decayed state, are only a nuisance.

I now come to the question of durability of wrought iron as a material for sleepers when laid in the ground. I have placed upon the table two tie-rods taken from the Guisbrough Railway out of the pot or bowl sleepers laid on that line, as before mentioned. They have been in use twenty-four years, under very heavy traffic indeed. One was taken out of cinder ballast and the other from gravel, from two different parts of the line. With the exception of the center of the bars, where the strain was heaviest and where there would be continual springing, I think you will all agree that there is another twenty years' work in them. A third bar about ½ in. thick has within the last few weeks been taken up out of the works of Messrs. Cochrane & Co. Middlesbrough, and has been in work sixteen years. This was also laid in ash and sand ballast, and I cannot see that it has depreciated in thickness in any way. Laid down as these have been in our damp Cleveland climate, it must be admitted that this has been a severe trial, and a far severer test than rails laid down and in constant use, which are constantly quoted as rarely suffering from corrosion. At the discussion upon Mr. Benedict's paper in Glasgow, Mr. Wilson says that on the Oude and Rohilcund Railway wrought-iron saddle sleepers had been employed for eight years, and that they did not suffer from corrosion. Mr. Weymers, of Brussels, in his paper read before the Institute last year, says that when the road is in constant use the sleepers remain free from rust. And there is a specimen on the table of a Barlow rail and sleeper combined, as seen on Diagram I., Fig. 1, which has been in use something like twenty years in Spain. Large quantities have lately been discharged in the Middlesbrough docks, and although the head of the rail is completely worn out, the flange or sleeper portion has not suffered in any way from corrosion. It seems to be generally understood that common wrought iron does not suffer so much from corrosion as mild steel or very pure iron. Some very valuable facts have been given by Captain Aynsley and others before this Institute to that effect. While, if we examine the common iron tie-bars and Barlow rail on the table, these facts seem to be confirmed, on the other hand I have been informed by one or two inspectors that in some of the tunnels near London the steel rails have suffered so much from corrosion that they have not lasted anything like so long as the iron rails formerly used. In fact, this rapid corrosion of steel rails in damp tunnels is quite a new feature, and one as yet without explanation. With all this evidence before us, I think I shall not be far wrong when I put down the life of a wrought-iron sleeper at forty-five years in European or damp climates, while in tropical or dry climates it will exceed this. And if Professor Barff's process for preventing corrosion can only be allowed to leave the laboratory of its very scientific inventor and pass into the atmosphere of practice, I have not the least hesitation in saying that, so far as corrosion is concerned, they will last much longer than this. It has been objected that in a country like India, when wrought-iron sleepers are worn out, they cannot be made use of again, while for cast iron there is always a demand at a good price. I have shown pretty clearly, from experience, that wrought iron will stand forty to fifty years. But we will suppose that after that time the Government should have a large quantity of these worn-out wrought-iron sleepers in stock. My advice to them would be to convert them on the spot into merchant bars. The quality must necessarily be pretty good, and re-heating, hammering, and rolling out would convert them into first-class merchant bars. This can be done in India for a sum under 30s. per ton. While I was engaged many years ago in the employment of the East Indian Iron Company we rolled large quantities of merchant iron. The re-heating and rolling caused but little trouble; it was the cost of the wood fuel and the difficulties connected with the puddling that failed commercially. The demand for merchant iron in India is always good, while the railway companies themselves will use considerably more than the old sleepers could give after forty or fifty years' work.

In connection with the employment of wrought-iron, steel, or cast-iron sleepers or bowls, an important question has come into play. I say play, because I shall be able to show that there is really nothing in it practically, although it is spoken of by many as if it were a necessity, whereas, on the main lines in England it seems to be perfectly ignored, even on the sharpest curves. I refer to the widening of the gauge or the distance between the rails going round curves. Mr. Benedict says in the paper before quoted, "With almost all the bowls that have come under my notice the gauge once fixed cannot be altered or widened as it should be on curves and in station yards." While the Vienna Exhibition Report upon Hilf's system has the following: "The necessary widening of gauge for the curves, the distance between the sleepers, and the various length of pieces, are marked on the engraving." (This has been done most scientifically and elaborately, but seems to me not of the slightest practical value.) Again, Mr. J. L. Weymers, in his paper last spring —*vide* "Journal" of this Institute, Nov. 1877—appears to place great importance upon a hexagonal eccentric washer, by which he says he is enabled to vary the width of the two rails as much as 1½ in., so as to suit all widths of rails in going round curves. He also mentioned a fact worth noting, viz., that Hilf's system requires no less than eight different gauges for the various curves. Some explanation may be found to this question of width and variation of gauge by the models exhibited, which show that the longitudinal system does require adjustment—see also Fig. 12. A A A shows the longitudinal sleepers, with holes punched at equal distances for the tie-bars to go through. Tie-bars are marked B B B. In going round a curve, therefore, the outside radius being larger than the inside, the inside rail or sleeper will reach further than the outside. The tie-bars, therefore, lose their proper radial position, and this would bring the rails closer together, as shown at B E, the proper distance being shown by the dotted line at B F, which thus accounts for many of these complicated adjustments, all of which are totally unnecessary in the cross-sleeper system.

I have pointed out these opinions publicly expressed, because of the supposed importance attached by some to the necessity of widening the gauge upon curves, and also because they are totally against my own practice even upon curves of a radius of from three to four chains, and carrying a traffic of over 700,000 tons per annum. I have even gone further than this. I have personally seen several of the head platelayers on some of the most extensive lines in England, and also the chief inspector upon the Stockton and Darlington Railway, and they all assure me that they use but one gauge either for curves or for the straight way. At my request, the gauge was tried on many sharp curves, carrying the whole of the heavy traffic of the Cleveland district, over which the six-wheel locomotives often travel at from forty to fifty miles per hour, and it was found that on the sharpest curve, where the rails had been down several years, there was practically no difference in the width between the rails. In one or two instances only we found the rails worn about ⅛ in. wide. In fact, the keeping of the rails to the gauge on some of the heaviest curves is considered of so much importance, that in addition to the heavy railway chairs which are held down on to the wooden sleeper with four iron spikes, lugs are cast upon the inside jaws of the chairs to take a heavy iron tie-bar to prevent the chairs spreading out. When the inside of the head of the rail becomes worn, the rails are lifted out and changed from one side of the line to the other; such a question as drawing the spikes out of a sleeper to bring the rails to gauge very rarely happens, except on very old lines where the chairs have little base and sleepers are very light.

I hope I have said sufficient to dispel the idea that adjustment of gauge on curves is necessary, and that whatever the theory may be, in practice—in England, at least as far as I can learn—it is never carried out, one gauge only being used. It seems to me, therefore, that any extra parts, any complication for adjustment of rails or sleepers, are refinements totally unnecessary in a properly-constructed permanent way, and only become necessary when the system is inherently wanting, or where the method of fastening the rails upon the sleepers is insufficient, in practical working, to prevent the rails or sleepers from spreading out wide, or the tie-bars radial.

This spreading out is especially troublesome upon those systems when the flat-footed rail is simply spiked down upon the wooden sleepers with dog spikes without chairs; more especially upon the curves in the narrow or 3-ft. 6-in. gauge, where the short wheel base of the small coupled engines throws a great strain upon the outer rails; and it is under these circumstances that the cross sleeper and clip-chair will be found most valuable. It will allow any amount of outward thrust, and will always remain perfectly true to the gauge, has ample bearing surface, has few parts, and is quickly laid down.

In foreign or tropical climates, a system that cannot be laid wrong, and one, as before pointed out, requiring no special gauges or tools, having no bolts, keys, cottars, or pins, requiring no adjustment, is one that I am sure will readily commend itself to those who have such uneducated labor to deal with as is generally found in those countries; while a resident engineer will be saved a great amount of anxiety in respect of maintenance of gauge and the general condition of the line, having also at the same time secured the whole of the good properties of the well-known and long-tried wooden cross-sleeper system, combination with a cheap, a far more durable and a stronger material, with fewness of parts, ease of packing, and lightness and facility of transport. Fig. 2 is a section of the well-known "Barlow" combined sleeper and rail. It consists of a hollow trough rail, with the flange much extended to form the base on which the bearing is taken continuously throughout its length, and resting on the ballast without either sleeper or chair. As far as I am aware this was the first wrought-iron sleeper brought into general use, and it is, without exception, the most simple permanent way ever introduced. Twenty years ago large quantities were made in different parts of England. When properly packed they answered very well, although they were said to be rather hard to run upon, and were also weak at the joints; but the great disadvantage was that when a rail became worn, rail, sleeper, and all had to be thrown away. There was also some difficulty in adjustment round curves. All, however, must admire its extreme simplicity. Fig 3 is a section of Hilf's longitudinal system, much adopted in Austria and other parts of the Continent; and although it seems to answer its purpose very well when once laid, the first cost, the large number of pieces, the complication of adjustment round curves before explained, must be a great drawback to its general adoption. Fig. 4 is a section of Hoenegger's plan, which, with the exception of the sleeper being of a different but of a more simple but weaker section than the last described, seems to me to have just as many parts and just as many drawbacks. Fig. 5 is a system by M. Thomnen, which appears to have many points of originality. The rail has only one head, but with a rather deep flat

web; the rail is suspended by the head upon the vertical webs of the longitudinal sleeper, which is in two parts, the web of the rail being nipped in a similar manner to a fish-plate, and secured by bolts. Fig. 6 is a section of Messrs. De Serres and Battigs' system, lately brought into prominent notice in Belgium, and seems to me to be an improvement upon that last described. You will notice that the rail is suspended by the head, the web passing between the vertical webs of the sleeper in a very similar way to that last described. The novelty, however, is that the rail is not fastened down, but is simply held by the mechanical nipping, or vice-like action, holding tightest when the weight comes upon the rail; and the sleeper being unable to spread out at the top, in consequence of a notch in the tie-bar and keys, it has a tendency to spread out at the bottom, acting in a similar way to a pair of smith's tongs, supposing the rivet was taken out and a hoop slipped over. The sleepers run about 15 ft. 6 ins. long, and each half sleeper is made to break joint with the other; the sleepers are held together by heavy tie-bars, which pass completely through the sleeper under both rails; the strain against the nipping action is taken oy a series of keys assisted by the tie-bars; the keys are placed about 2 ft. apart, and the tie-bars about 8 ft. apart. Both the keys and tie-bars are rolled from one section of bar, the tie-bars having deep notches cut into each end, and the keys also one notch in the center, into which the vertical web of the sleeper drops, the notch completely retaining the sleeper at the neck, thus taking the whole of the strain.

These tie-bars are about 4⅜ ins. deep, and weigh about 70 lbs. each, and the keys about 10½ lbs.; they thus form a considerable item in the weight of the system. This extra heavy weight does not assist in any way to carry the load or the sleeper-bearing surface, and, therefore, to a certain extent is useless. There is also at the foot of the sleeper a considerable increase of metal, rendered necessary on account of the sleeper being cut almost in halves for the insertion of the tie-bars and keys. Considering these all weaknesses inherent to the system, and although the rail is lighter, through having only one head, as in Thomnen's, there is an excess of metal in other parts which should not be required, and which does not in any way assist in the stability of the road. Beyond this I must say the system is ingenious—has few parts, no bolts or nuts, and will go together very well; but there must be difficulty in adapting the system round sharp curves, and I am not sure that an English engineer would be quite satisfied with a rail under heavy traffic being held down simply by two split pins, one at each end of a long rail. I am afraid if there should be a settlement of the sleeper the rail would be likely to get out of its place. Fig. 7 and 8 is my own system of cross-sleeper, with its simple but secure fastening every 2 ft. 9 ins. or 3 ft.; but, as I have already fully described these before, I will pass on, mentioning only the fact that they are as easily packed and lifted as an ordinary wooden sleeper. Fig. 9 is Potel's plan, which was fully described in an interesting paper read in this hall last year. The sleeper is all right, but the jaw-bone chair has, in my opinion, many objections.

Fig. 10 is a section of the ordinary pot or bowl sleeper. This type is perhaps the most extensive iron permanent way in use, and has found great favor with engineers in hot countries. I have, however, already pointed out some of its defects. Fig. 11 shows M'Lellan's steel or wrought-iron plate sleeper. You will see that it is a kind of square corrugated bowl, and possesses many points of merit. It is said to be elastic, very light, strong, and, when of sufficient thickness, packs very well for transport, and will not break. They are tied together in the same way with a tie-bar, gibs, and cottars, as in the cast-iron bowls; they are easily lifted when leveling the line, and no trouble is found in the packing; there are, however, a good many separate small pieces to look after, and must accordingly be rather expensive. I have, in the following table, given a list of the number of separate pieces to each yard of railway, the rails not being included. Calculating that the sleepers are placed one yard apart, center to center, those engineers accustomed to prepare a permanent way to send abroad will well appreciate the small number of parts to be ordered, which their skilled inspectors have so carefully to watch, and any system of permanent way, complete in itself, with only two pieces of iron of different forms to be contracted for and inspected, and without bolts, nuts, keys, pins, etc., must be brought under most favorable notice. Number of separate pieces per yard on the various systems noticed in this paper:

Barlow's	about	3	pieces per yard.
Hilf's	"	22	" "
Wrought-iron bowls	"	25	" "
Cast-iron bowls	"	9	" "
Hohenegger's	"	25	" "
De Serres and Battigs'	"	3¼	" "
Potel's	"	21	" "
Wood's cross sleeper	"	5	" "

In conclusion, I must again express my regret if, in collecting the numerous facts placed before you, I have said anything in my paper which may be considered otherwise than a fair criticism. I know that I have touched upon some tried and well-worked systems. I know, also, that there are many systems of iron permanent ways which I have taken no notice of. This has been with no intention on my part to overlook them, but rather that, by picking out one or two examples of each known type, I might the better explain my own views more fully.

RAILWAY APPLIANCES AT THE PHILADELPHIA EXHIBITION.

THE following paper on this subject was lately read before the Institution of Civil Engineers, London, by Douglas Galton, C.B., F.R.S.:

Although the first American railroad was only constructed in the year 1830, about 22,000 miles were in operation in 1856, and 74,600 miles in 1875. The difference between the European and American railroad systems was very marked. In Europe the railway was originally looked upon rather as a means of diminishing distance by high speeds than as the universal road for traffic. In America, where the railway had been the pioneer road of the country, and the sole means of communication, circumstances prevented the investment of more capital than was sufficient to make a line adequate to perform the duty immediately required of it. But, while the first cost was thus limited, considerable expense had to be subsequently incurred in perfecting the line. On the early American railroads the sleepers were laid on the soil, with little or no ballast. Sharp curves and steep gradients were the rule, so that a short rigid wheel base was imperative. Again, a car resembling the saloon of a steamboat was adopted, rather than a development of the body of a stage coach, as on European railways. The cars had central couplings, with end doors and steps, so that station platforms were unnecessary; and the traffic, until recently, had not demanded expensive signal arrangements. More responsibility appeared to have been thrown on the engine-driver, and improvement had been mainly in train appliances, such as brakes. It was believed that while the railways in Australia and other British colonies and in India were still in their infancy, advantage would accrue from a careful consideration of the American system.

The subject was treated under the following heads: I. Permanent way; II. Cars and car fittings, including (*a*) wheels, (*b*) axles, (*c*) couplings, (*d*) springs, (*e*) brakes, and (*f*) heating apparatus; III. Locomotive engines; IV. Railroads of 3 ft. gauge. The main features of the standard track of the Pennsylvania Railroad Company consisted in the shape of the head of the rail, the form of splice for the joints, the large number of sleepers, and the arrangement of the ballast. The splices were 2 ft. in length. The outside splice had a tongue which passed over the flange of the rail and was spiked to the sleepers. The joint was suspended midway between two sleepers. The surface at the formation level had slopes of 1 in 20 from the center outward, and the ballast was so laid as to allow the water to drain off rapidly. The weights per wheel in the heaviest engines were about 4½ tons. In connection with the permanent way, attention was directed to the Wharton switch, the principle of which was to carry the train off the main line on to a siding, without any break in the continuity of the main line rails. The great distances on American lines had led to the conversion of the passenger cars into traveling hotels. The main advantage of the American form of car, which consisted of a long body supported at each end on a bogie truck, was the power of movement afforded to the passengers, and of access to conveniences. The disadvantages were the mode of opening the windows, which slid up instead of being let down into the panels, and the difficulty of ventilation, but the latter had been overcome by a central raised roof with clerestory windows. A car for sixty persons had a length of body of 48 ft., a width of 9 ft. 6 ins., and a height of 7 ft. 10 ins. at the sides and of 10 ft. 3 ins. in the center. Such a car would weigh, when empty, 650 lbs., and when full, 783 lbs., per passenger. Sleeping cars for sixty-four persons were made with a body 61 ft. long, and weighed, when empty, 812½ lbs., and when full, 945½ lbs., per passenger. A class of vehicle recently adopted seemed likely to come into greater use. This was the refrigerator car, by which the produce of California was brought to the Eastern States, and the delicate fruits of the South and fish from the Gulf of Mexico were taken to Chicago. These cars were fitted with ice boxes, and were of various patterns. A very efficient cooling surface was provided by two ice chambers on each side of the car, or four in all, extending from the top to the bottom, and fed through hoppers in the roof. These boxes, being placed 3 ins. from the sides, allowed a free circulation of air all round.

The use of chilled cast-iron wheels was all but universal on American railroads. Each wheel formed a single casting with the tire, and was cast in a chill, consisting of a rim of iron turned perfectly true, so that labor in turning was avoided. The necessary hardness in the chill was obtained by a mixture of charcoal iron, chiefly Salisbury iron, with broken up wheels and castings. The comparatively high price of charcoal iron had led to the substitution for it in part of anthracite iron, with wrought iron or Bessemer steel. A brief account followed of Messrs. Lobdell's mode of manufacturing wheels with charcoal iron, while the processes of other makers, and of Mr. Hamilton's successful use of anthracite iron, were briefly referred to. The duration of car-wheels in the United States was stated to be from 50,000 to 60,000 miles. They could then be turned up and run a further mileage. If turned before being used, Messrs. Lobdell guaranteed a duration of 90,000 miles. From numerous inquiries, the author had arrived at the conclusion that good chilled cast-iron wheels were economical, and that they did not break in a way to occasion accidents to trains, provided they were periodically examined when running. Three axles were noticed, in each of which the object was to allow the wheels attached to them to revolve independently. The construction of the Miltimore axle—one of this class—was described in detail, as with it there was a marked diminution of friction in passing round sharp curves. The results of two experiments were recorded, which showed in one case there was a friction of 13·15 lbs. per ton in the Miltimore axle, as against 17·21 lbs. per ton with an ordinary axle, while in the other case these figures were 13·67 lbs. and 26·55 lbs.

The Miller coupling and buffer, now generally adopted in the United States for passenger cars, consisted of a spring buffer with a coupling immediately under the center of the buffer. The buffer was in the plane of the sill of the car, and the compression was also in that plane, so that there was no tendency for the sill of one car to rise above the sill of the adjacent car. The coupling consisted of a broad catch attached to the end of a spring draw-bar. This hook caught the opposite hook sideways, as the elasticity of the head of the draw-bar afforded a slight lateral motion. When the cars were run together, the ends of the hooks first passed each other, then sprang back so as to form a secure clasp, the buffers being at the same time brought into compression. All this was effected without the use of links or pins, or the intervention of men to make the attachment. The uncoupling was accomplished by a vertical lever attached to the railing of the platform, the lever releasing one hook from its hold on the hook of the adjacent car. In springs, the greatest novelties were spiral springs in nests, and spiral steel springs combined with India-rubber.

The brakes on American railroads were, as a rule, capable of being applied to a larger number of wheels in a train than in this country. This had probably arisen from the greater necessity for the rapid stopping of trains, owing to the absence of secure fencing and the prevalence of single lines. It seemed to be recognized in the United States, first, that the engine driver should have complete control over the application of brake-power to all the wheels of the train; and secondly, that, in the case of the accidental fracture of the coupling, the detached cars should be at once brought to rest by the action of the brakes attached to them. The Westinghouse automatic air brake was in extensive use on American railroads, especially for passenger trains. In it the air in the pipes was pumped in continually under pressure, and the brakes were applied by diminution of pressure. Smith's vacuum brake—the property of the Westinghouse Brake Company—was occasionally employed, where rapidity of action was not of paramount importance. It was less expensive, and its action was dependent upon a vacuum in the pipes.

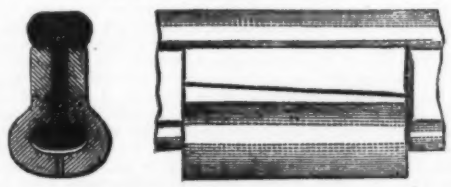
The method formerly in use in America for heating the cars was by open iron stoves, but these had been the cause of many frightful accidents from fires. The Baker car warmer seemed now to be in great favor. In this the heat was applied by hot water pipes laid round the car on the floor-level, the water being heated by a coiled portion of the pipe being passed through a circular iron stove. The fire-box of this stove was of wrought iron, and this again was contained in a second covering of iron, which terminated in the chimney. No instance was on record of a fire having been occasioned in a train from these stoves. For the circulation, both ends of the pipe were inserted in a close cylindrical cistern on the roof of the car. The liquid used was a saturated solution of salt water, as this solution did not freeze at ordinary low temperatures. The safety-valve had a compressible India-rubber ball, as the crystals of salt prevented a metal-seated valve from shutting tightly. The average allowance of heating surface in an ordinary car was 11 ft. of 1¼ in. pipe per passenger.

The striking fact gathered from the exhibition of railroad cars at Philadelphia was that, while the comfort of railway traveling had been practically stationary in Europe for the last twenty-five years, it had been rapidly developed in the United States within the last few years to a standard above that of Europe. The comforts were as much needed in Europe. The distances were as great; the cold was as intense; the populations to be accommodated were as numerous, and more wealthy. No doubt the control exercised by Continental governments had had some effect in stopping improvements, but the author believed the stagnation was largely due to the use of small carriages divided into compartments. These had actually prevented the development of comfort, while the larger American car had both suggested and afforded scope for improvement. Until European railway companies followed the lead of America, and adopted long carriages on bogie trucks, comfort in traveling would remain in its present unsatisfactory condition.

Locomotive engines in the United States were of a totally different type to those in Europe. The front part of the engine was supported on a bogie truck, by which a short wheel-base was possible. This truck was generally so arranged that the pivot was under the center of the smoke-box, and the front wheels were considerably in advance of the body of the engine. When a bogie truck was not used, the front of the engine was carried—except in the case of a few special engines for inclines or for switching—by a Bissel two-wheeled "pony" truck, which had a swing bolster and a radius bar pivoting from a point about 4 ft. behind the center of the truck, the weight being equalized between the pony truck and the leading pair of driving wheels. The center of the smoke-box was equidistant between the leading pair of driving wheels and the pony wheels. The cylinders were horizontal, placed low down between the front pair of wheels, and cast in one piece with the half saddle fitting round the bottom of the smoke-box, under the center of which the two parts were bolted together. The cylinders were thus right and left indiscriminately, and a single pattern answered for both sides. The boilers were of charcoal iron or of homogeneous steel. The tubes were also of charcoal iron, lap welded. The fire-boxes were of American homogeneous steel, English steel of a high temper having been found to crack and blister. The particulars were given of five classes of engines built at the Baldwin Locomotive Works, and of their performances. It appeared that the tractive force required to draw a train on an American railroad was less than on an English railway, so that either the train resistances were less or the average adhesion was greater. The dryness of the climate was more favorable to adhesion. In America the average train resistances were diminished by the use of the bogie truck, possibly also by the employment of oil in the axle-boxes, but the main cause was dependent upon the short rigid wheel-base. If to this could be added some form of axle, such as the Miltimore, which would admit of the wheels moving independently, considerable economy in the tractive force required on railways would result.

Within the last few years companies had been formed to build in America 8,000 miles of narrow gauge lines, of which 2,700 miles were in operation at the beginning of 1877. The Denver and Rio Grande Railroad was proposed to be 1,700 miles long, and between 200 and 300 miles had been completed. The promoters of this system contended that a mile of single line having a gauge of 3 ft. could be made for £1,904, with rails weighing 30 lbs. to the yard, or for £2,144, with rails of 40 lbs. to the yard, while the rolling stock might cost £758 per mile, calculated for a length of 100 miles of road. The details were added of the engines and rolling stock for a gauge of 3 ft., and a contrast was made between it and the stock for a gauge of 4 ft. 8½ ins. The 3 ft. gauge railroads were introduced in the United States as economical pioneer lines, and so long as they were retained in that capacity they might be useful for opening out a country where the traffic was small. They had also been found peculiarly applicable in penetrating into the narrow cañons and gorges in the hills of Colorado. But it was certain that, where special conditions did not prevail, and as the traffic increased, the inconvenience of a break of gauge would be more serious, and a wider gauge would be found preferable. It was, however, worthy of consideration whether in the colonies narrow gauge railroads, of cheaper construction and with cheaper plant than the 4 ft. 8½ in. gauge, might not be advantageously adopted, and amply suffice for the wants of such communities.

IMPROVED RAIL JOINT.



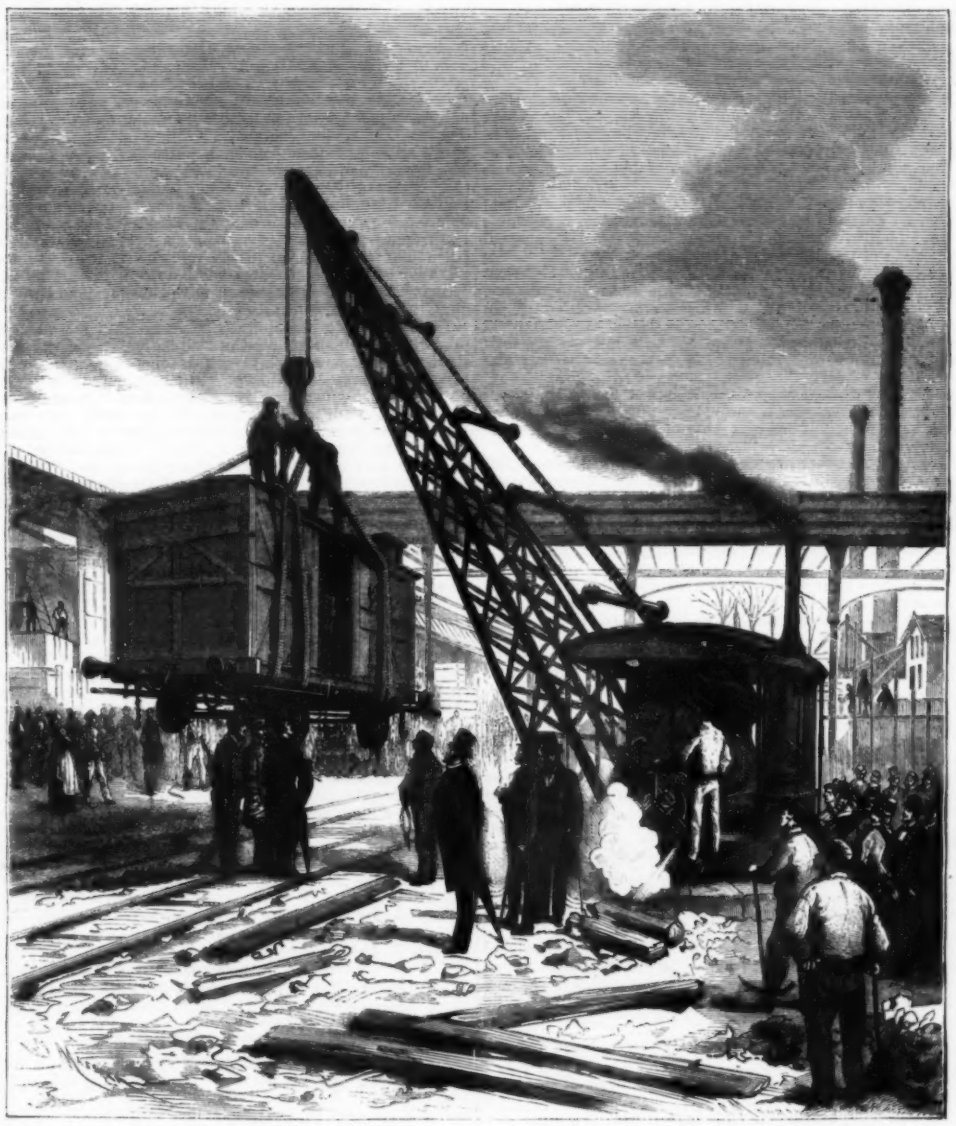
THIS improvement is by A. J. Acaster, Sheffield, England, and will be readily understood by a glance at the figure.

WAGES IN AUSTRALIA.

AVERAGE wages per day of ten hours: Carpenters, $1.25 to $2; roofers, $1.75 to $2.50; engineers, $1.50 to $2.50; painters, $1.23 to $2; machinists, $1.25 to $1.75; coopers, $1.50 to $2.50; box-makers, $1.50 to $2.50; ship-carpenters, $1.50 to $2.50; wagon-builders, $1.75 to $2.50; blacksmiths, $2 to $2.50; boiler-makers, $1.25 to $2; harness-makers, $1.50 to $3.50; glass-blowers, $1.75 to $3; cabinet-makers, $1.25 to $2; pianoforte-makers, $1.50 to $2.

THE VORUZ DERRICK AT THE PARIS EXPOSITION.

WE take from *L'Illustration* the annexed engraving of one of the large derricks used for moving heavy objects in the Paris Exposition Buildings. The central foundation of iron weighs 19,800 pounds and is placed in an excavation lined with masonry and some 16 feet in depth. Above this is a massive platform, which on one side supports the boiler and on the other the derrick and hoisting apparatus. When the weight to be raised is light, hand power may be applied to the cranks; when heavy, the two steam engines are employed to wind the chain, which extends over massive rollers on the



THE PARIS EXPOSITION.—NEW RAILWAY CAR DERRICK.

arm. Mechanism is provided whereby the engines may be instantly reversed or the load held suspended at any point. The total weight of the machine is 77,000 pounds, and is sufficiently strong to lift bodily a loaded railway car weighing over ten tons from one track to another. The derrick arm has a reach of 24 feet, and thus is capable of moving a weight over a total distance of double the above.

The entire apparatus while exceedingly simple in construction is remarkable for the smoothness with which it works and the facility with which it is operated.

EMERY AND CORUNDUM WHEELS FOR GRINDING AND SURFACING METALS AND OTHER MATERIALS.*

By ARTHUR H. BATEMAN, F. C. S.

THE two great divisions of the metal industry are the elimination of metals from their ores, and their working up into forms for use.

The first class involves highly scientific processes, chiefly carried out by unskilled hands; the second necessitates individual skill on the part of the workers.

The chief means of working up metals are casting, forging, and shaping, both of the former requiring more or less of the latter, and in each the removal of superfluous metal plays an important part. This is effected chiefly by files and chisels, to some extent and in some branches also by grindstones.

A file is a specially prepared tool, of which only a very small percentage can be considered to be practically useful. A chisel is the same, and requires constant attention to its small cutting edge, the great bulk of its weight also being useless for its actual work. A grindstone, reduced to its elements, is composed of a large number of particles of natural material, mostly silica or its combinations, the individual grains of which are irregular in hardness, shape, and size, mostly smooth, and comparatively rounded. It will attack hard metals, which the file and chisel will not, but, owing to the difficulty of securing real homogeneity, it cannot with safety be run at the speed requisite to utilize its full cutting power.

For rapid working of hard materials, whether metals or stone, etc., something harder and more lasting than these tools is required, and for many centuries natural substances have been used to assist.

It is probable many of the ancient gems now in existence were cut by the help of emery powder, and to this day the Indian and Turkish lapidaries use a wheel compounded of shellac and this material, rotated with a drill bow. This remarkable substance is often spoken of as steel filings, or as an oxide of iron, but it is really a mixture of corundum and oxide of iron. Corundum itself is almost pure alumina with a little silica, and, in its purest form of all, slightly tinged with iron oxides, is sapphire and ruby; in a less pure state, and with traces of various foreign substances, it is of commercial rather than fancy value, and is found in unimportant quantities in various parts of the world. It is also known as adamantine spar. Comparatively recently large deposits of corundum were ascertained to exist in America, and it is a somewhat singular fact that this took place almost simultaneously with the discovery, in 1847, by Dr. Lawrence Smith, an American geologist, of the now famous Turkish deposits of emery. The former, however, were allowed to lie dormant until 1865, while the latter, being brought to the notice of the Government, were almost immediately utilized. Further investigation showed these deposits to be of considerable magnitude. The chief are near Smyrna and the ruins of Ephesus, also in several islands of the Greek Archipelago, notably Naxos, from a promontory in which island—Cape Emeri—it takes its name. Deposits of little or no commercial importance are also to be found in Jersey, Spain, Poland, Saxony, Sweden, Persia, and the Andes of South America. Quite recently, it is stated, important discoveries of emery in a granular form have been made at the Adirondacks, in the North American Continent.

Although called mines, the emery workings are really on the surface only, or very little below the surface. The dark red color of the ground affords a pretty sure indication of its presence, but steel rods are struck into the earth, and a practiced eye soon detects the presence of emery rock by the markings on their points. The mineral occurs chiefly in large masses, sometimes susceptible of rough breaking, at others resisting blows. In such case a fire is lighted round the refractory lumps, and on cooling, after some hours of heat, they will often be found more amenable to treatment. Blasting is seldom practicable, from the difficulty of drilling holes. As transport to the sea is solely attainable on the backs of mules and camels, a weight of about 100 lbs. is considered the practical limit for individual lumps. The Turkish and Greek governments sell the monopoly of raising emery rock, and for many years nearly the whole has been controlled by English capitalists; in fact, until recently a company known as the Levant Company have had the practical control of the market. During the last few years there has been more independent working, and the supplies have been large, but at the same time a greatly increased quantity of inferior rock has come to England. It is chiefly sent over as ballast; freight thus is an insignificant item.

The specific gravity of emery ranges from 3·75 to 4·28, and may be taken to average 4·0; the color varies from dark gray to black, and is no indication of value. Owing, however, to general misappreciation of this fact, some English firms color their crushed emery to a uniform tint, and uncolored emery is often unsalable, and put down as bad or impure by buyers used to a particular shade.

Nothing is done in the producing country beyond the rough sorting and breaking into lumps under the above limit of weight. On arrival in this country the emery crushers submit it to treatment, to render it available in manufacturing processes. There are but few firms in this trade—until within a few years since only four or five, but at present more are engaged in it. As a rule, emery crushing works are not shown in operation. Several processes are employed, each being held to possess its own special advantages. First, the rock is crushed into pieces about the size of walnuts, by passing again and again through Blake's or other crushing machines; it is then either stamped with stampers, passed between chilled rolls, or through grinding mills, the latter being circular cast-iron plates with upright lands six or eight inches high. These wear away by degrees, as may readily be believed, but last from four to six weeks. The jaws of the crushers last from two to three weeks; stamps last longer, but work slower; of the life of the chilled rolls I have no information. Microscopic examination of crushed emery shows not only the distinct presence of the two substances, corundum and oxide of iron, with a certain percentage of quartz which is often mixed with the emery rock, and a trace of iron from the machines, but also in many instances iron slag and other similar substances used as adulterants. It is by no means certain that some such substances may not be a positive improvement in some respects, as causing a freer cut, but in this case it is certainly desirable that any such admixture be made by the user and not by the crusher. All makers of solid emery wheels guarantee that they use pure emery, but as only one firm crushes its own rock, the microscope should always be used to see that what is bought as pure emery really deserves that name. The microscope also shows that there is little, if anything, to choose between the grains produced by rolling, crushing, stamping, or milling, as far as regards sharpness of angle. The great points seem to be attention to quality of rock, careful removal of bad pieces containing foreign matter, and accurate sifting.

By the kindness of Messrs. Acton & Borman, who have large emery crushing mills, I am enabled to show a very good selection of emery rock, good, indifferent, and bad.

After the emery has passed through the machines it is sifted through a series of sieves, ranging from 6 to 100 linear meshes to the inch, and all pieces larger than the former size are returned to the machines for further crushing. The process is an eminently dusty and disagreeable one, and from the beams, roof, and upper parts of the crushing shops is collected what is known as flour emery, which has deposited from the atmosphere. Finenesses of 120 and even 140 are thus obtained. Still finer grades are, however, required for polishing plate glass, opticians' work, etc., and for this the very beautiful process of elutriation or washing over is employed. A dozen or more metal cylinders, three or four feet high, and ranging from three inches to 36 or 40 inches diameter, are connected near their upper edges by pipes; the whole series is filled to the brim with water; emery and water well mixed are introduced into the smallest vessel; the water, of course, flows out at the opposite pipe to the next, and so on through the whole series. The coarsest powder falls during its three inch journey across the first cylinder, the next coarsest through its four inch, then its six inch, and so on, until at last practically pure water flows from the exit tube of the last 40 inch vessel. After a time the process is stopped, the material allowed to subside, the superincumbent water decanted off, and the deposited emery removed and dried. This process is carried out by the users, not by the crushers.

The chief use to which powdered emery has been put is, in its raw state, in metal workshops, also for gluing on to sticks of the shape of files, for use with lead laps or polishing wheels, and glued to paper or cloth, in which form it is generally used by mechanics, wrapped round a stick or flat piece of wood. Paper seems better for this purpose than cloth, though the latter is preferable where it is used without such support. Envelopes of emery paper with shaped sticks have also been patented, but have never come into general use. Emery has also long been extensively used for buffing and polishing, by covering a wooden disk with leather, gluing fine emery on to the surface, and rotating it when dry at a high speed. The yielding nature of the latter causes this to be absolutely unsurpassed as a polishing medium for hard metals or other substances.

In 1842 Henry Barclay patented a process for a solid emery wheel, using an equal part of Stourbridge clay and emery, pressing the wet mixture into moulds, and subjecting it to a bright red heat. This is said to have given a really efficient wheel, but it does not appear to have been practically worked, as only small disks, say eight or nine inches diameter, could be made, owing to the difficulty of avoiding cracks and distortion in the process of firing. It is satisfactory to know that the actual father of the modern emery wheel was an Englishman, although the development of the idea has certainly taken place on the other side of the Atlantic, and we are now appearing to be copying our American cousins in our tardy adoption of a *bona fide* English invention. About ten years later, I believe, efforts were made to introduce and extend the use of solid emery wheels by Mr. (now Dr.) Anderson, then of Woolwich Arsenal, but it has only been during the last five or six years that anything approaching to general attention has been paid to the subject.

Five years ago there were many makers of solid emery wheels in America, but only about four in England; at the present moment there are double this number, and one of the leading American makes is personally represented in this country. Notwithstanding the depressed condition of the metal trade, the sales of most of these makes have probably something like doubled annually of late, showing that the subject is one assuming real commercial as well as scientific importance, and worthy of the attention of the members of this society.

An important peculiarity of emery or corundum is its extreme hardness. The diamond is the hardest substance in nature; absolutely pure corundum, in the form of sapphire and ruby, comes next; the commercial variety is scarcely inferior, and closely approaching is emery; but a still more important feature of the latter substance is its tendency to break with a rough surface, or what is known as conchoidal fracture. However finely the rock may be crushed, this roughness still exists, and even flour emery, examined under a moderately high power, is found to sustain this peculiarity, and to present a series of sharp angles and points. As an individual grain wears smoother by friction, it still, to a great extent, carries out this disposition, so that a disk or wheel made of grains of emery, if properly cemented together with a binding material that will not melt and form

* Read before the Society of Arts.

a skin on the cutting surface (as is sometimes the case), presents a constant succession of fresh cutting surfaces.

The question has been asked, whether a disk of solid emery rock would not be better than crushed grains cemented together again. The answer is obvious, that the vast amount of rough surface present in the built-up wheel would be absent in the solid mass, quite apart from the extreme difficulty of manufacture.

The peculiar property of conchoidal fracture above referred to, as possessed by emery, is not shared in anything like an equal degree by corundum, and although in crushing this latter mineral many sharp points are obtained, there are also considerable plain and curved surfaces, never seen in the somewhat less hard emery. The result is as might be anticipated—the process of manufacture being the same, a disk of corundum will, under similar conditions of running, do as much, or perhaps more, work than a similar disk of emery, but it will heat the metal much more, because, while emery with its sharp points cuts its way, corundum, with its harder but smoother faces, tears its way into the work. For certain purposes, where it is possible to run in a constant stream of water, corundum wheels appear superior to emery, but for the general run of engineers' work, which is certainly on the whole done best dry, for tool grinding, and, indeed, most other purposes, our English experience is so far vastly in favor of emery over corundum wheels. A common form of corundum is that known as "ruby;" this is found in small grains averaging about 24 grade. It is waterworn and rounded, and breaks with comparatively smooth faces. This material crushed, however, makes very good fine wheels.

The natural corundum of North America, which is much rougher in grain, has been specially worked up by Messrs. Morton, Poole & Co., of Wilmington, Delaware, with the special object of truing chilled rolls. I am not aware of the process used, but am informed that extremely good results have been obtained. This same operation is, however, conducted in Belgium, Germany, and elsewhere, with emery wheels, with entire success.

The microscopic projection on the screen of actual grains of emery and corundum clearly shows the peculiarities of the respective substances, and to emphasize the distinctive characteristics of numerous small points *versus* larger points and wide planes, I add projections of sands, crushed grindstone, flint, and glass. You will observe at once that the sharp points of the latter substances must give good work until broken off, when the cutting power will vanish. You will also note the smooth and round appearance of the grains constituting the ordinary grindstone.

These projections indicate the probable relative cutting power of the various grains available for the manufacture of grinding wheels. It now remains to consider the best means of agglomerating these grains into a solid mass and utilizing the same.

It is manifest that, by the adoption of the circular form, steam power may be used instead of manual labor, and if a cement of sufficient strength be employed to withstand the centrifugal force (which increases as the square of the velocity), we have the remarkable result of, on the one hand, a steel file moving at the rate of about 60 feet per minute, driven by a man whose arms grow tired, and the tool itself useless when under 5 per cent. of its weight is used up, and on the other a circular file much harder than steel, whose cutting face never grows dull, driven by a steam-engine which never gets tired, at a speed of 5,000 feet per minute, and which can be used up to the extent of about 90 per cent. of its original weight. Small wonder, therefore, is it that rapidity, economy, and precision are obtained by this new tool, and that it has shown rapid growth since it first obtained a footing in English workshops.

Circular steel files (of which a specimen is on the table) have been tried more than once, run on a lathe or other rotating spindle, but their high cost, and the difficulty of preserving a flat face during the hardening process, and the small percentage of useful material, combined to prevent them coming into general use.

It may be asked if one half of what is claimed for the solid emery wheel be true, how is it that, instead of a gradual introduction, it does not instantly take its place in every workshop in the kingdom?

The answer is fourfold. 1st. The English working man (and to a certain extent the master also) is intensely conservative—why should he now use a tool he has done without all his life? 2d. It is said we cannot be perpetually adopting American "notions"—forgetting this is really an English notion adopted by the Americans because they have found it to be a real economy, which enables them to positively compete with us in our own markets, in the face of the heavy charge for 3,000 miles of carriage. 3d. It has already been tried and found a failure—probably put to unsuitable work, something that could not be done any other way, and an expectation formed that the new tool could be used in a moment without practice, condemnation following, because immediate success was not obtained. 4th. A dread, or fancied dread, of the necessary speed—quite oblivious of the fact that our trains run faster, our circular saws run faster, our wood-working machines run faster, and that with the proper and ordinary precautions requisite in all high speed machinery, there is no more danger than with many tools in everyday use already.

The novelty of emery wheels has caused the few accidents that have happened to be noised abroad, while those occurring with grindstones excite little attention. After considerable research, I am unable to obtain actual figures on this subject, but there is little doubt in the minds of those qualified to judge that the percentage (not the number) of emery wheel and grindstone accidents is much in the same ratio as those of railway trains as compared with stage coaches.

It may again be asked, Have any firms of repute, after introducing emery wheels, discontinued their use? In some few cases this has been the case, the reason given being that the opposition of the workmen did more harm than the use of the wheels did good; but coupled with the avowed intention to try again Later on. On the other hand, the firms who have extended their use of this labor-saving invention, after their first trial, are large in number and an ever increasing quantity. In many shops grindstones have vanished; in others the file bills have been cut down to one-half and one-third; in others, again, work heretofore impossible has been successfully accomplished, and materials hitherto unavailable have become admissible. A file can cut nothing harder than itself, and hard steel and chilled cast iron defy it. These materials are readily amenable to the solid emery wheels, and a new art has sprung up with their introduction, that of shaping dead hard metal either flat or cylindrical, instead of turning and subsequently hardening, the latter process not infrequently resulting in the destruction of accuracy by twisting and warping. Specimens of such work are on the table.

To the manufacture of a good solid emery wheel three essentials combine—good emery, good cementing materials, and extreme care in their combination. Probably the earliest commercially successful solid English emery wheel was that introduced 16 years ago, under the patents of Coles, Jacques, and Fanshawe, in which the cementing material is that curious compound known as oxidized oil, largely used in the well-known linoleum. The cement and emery are intimately admixed, pressed into accurate metal moulds, and subjected to a high temperature under the action of superheated steam. The resulting wheel is remarkably strong and homogeneous, is susceptible of manufacture in very thin disks, being to a certain extent flexible, and although giving off some slight smell in use, is widely accepted as a very valuable wheel. Another form is manufactured with shellac as its binding material, the ordinary smell of this substance being almost overcome by a peculiar mode of manufacture not made public. This process can be applied also to covering light iron pulleys, rims, and plates of metal, and is said to give good results.

A recent introduction to this country is the manufacture of what is known as the Union wheel in America, but is here called the Magnesian, from the fact of the cementing substances being oxychloride of magnesium. A positive stone is the result, for which enormous inherent strength is claimed, while a low rate of speed is nevertheless recommended as the best for cutting. Yet another process is that of Mr. F. Ransome, in which silicate of soda (dissolved flint) being mixed with the emery grains, together with a small proportion of free lime and a natural soluble silica, double chemical decomposition is set up, resulting in the almost entire change of the three cementing substances into the one insoluble silicate of lime, which binds the emery in enormously strong bonds, the action being facilitated and hastened by the application of gentle heat, not baking, as is sometimes erroneously stated. A remarkably strong and free cutting wheel is the result. Being hard and unyielding, thin disks require considerable care in use, but the inherent strength of the material is enormous, and when sand is used as the base instead of emery a most successful building stone is produced.

Two or three other processes are also used in England, but are not made public. Samples of the wheels referred to are on the table with portions of the majority showing the internal structure of the finished wheels.

On the European Continent, besides imported wheels, there are several local makes of varying degrees of merit, but mostly cheap (or rather low-priced), and with greatly less cutting power than English and American wheels.

In America, the natural home, at present, of the solid emery wheel, the processes are numerous and the sales very large. The Tanite, now represented in England, has long enjoyed the reputation of being the standard wheel; it is the highest priced; the cementing material is believed to be a solution of leather. The Union wheel (called Magnesian in England) took the Philadelphia Exhibition medal in 1876, and now claims to be the leading American wheel; it is sold in England under the auspices of a highly respectable London firm. Others may also be named: The Northampton, enjoying a good reputation; the Vulcanite, calling itself the genuine and original; the Climax, claiming to be made of American emery recently discovered in the Adirondacks, and to dispose of a cubic inch of cast iron in 49 seconds; the Vitrified, a porous wheel with a central water supply; the Cosmopolitan, and many more. Each of these wheels—or rather their makers—claims to be positively the best, some advocating high, others low speed, and generally indulging in those little amenities at the expense of their rivals, fortunately more common across the water than with us.

Turning now to the uses of emery wheels, both actual and prospective, I have obtained particulars of the uses to which they are put at the present moment in this country, and submit the following list, which, however, probably by no means exhausts the subject:

1. Fettling castings, steel, all kinds of iron, brass, and gun metal.
2. Grinding cranks and crank pins in hard, chilled, and case-hardened iron.
3. Surfacing locomotive slide bars.
4. Truing case-hardened and chilled rolls.
5. Bushes for axles; brazed joints of tubes.
6. Clearing grooves of oilcake chilled press plates.
7. Drums and pulleys, either entire, or for starting the skin to allow lathe tool to enter.
8. Finishing forged connecting rods, pistons, glands, valves, bolts, and nuts.
9. Cleaning wheel teeth.
10. Saw sharpening and gulleting.
11. Plowshares and reaper knives.
12. Work for galvanizing.
13. Tips and heels for boots.
14. Long cutting knives—paper, leather, tobacco.
15. Iron and brass stove and fender work.
16. Iron and brass taps, cocks, and valves.
17. Sewing machines, including spindles.
18. Slides for rests, beds, mortising machines, etc.
19. Cards on cylinders of carding engines.
20. Shuttle tips.
21. Spades, shovels, forks, etc.
22. Cast-iron railings.
23. Grinding "doctors" for print works
24. Tool grinding and sharpening.
25. Twist and other drill sharpening.
26. Hard steel magnets.
27. Gauges for fine work to $\frac{1}{1000}$ of an inch.
28. Mowing machine knives.
29. Fitting keys, etc.
30. Ends of shafting.
31. Lathe center grinding.
32. Nuts and rivet heads in iron safes.
33. Ends of iron columns.
34. Sad irons.
35. Moulding bits.
36. Gas fittings.
37. Locks.
38. Planing true surfaces.
39. Dies for punching.
40. Nail machinery.
41. Cutlery work.
42. Milling tools.
43. Mill bills.
44. Shoe cutters and lasts.
45. Dentists—metal and teeth.
46. Millboard.
47. Stone.
48. Agate.
49. Wood.
50. Bricks.

To this somewhat formidable list may be added many minor uses that will readily suggest themselves.

In conclusion, a few practical remarks may be offered. A common delusion prevails that an emery wheel is a tool requiring neither skill nor practice, and it is left to any one who chooses to work it. The result of this same system, as applied to grindstones, has caused that article to assume the simply disgraceful appearance it often exhibits—untrue, worn into grooves and hollows, no one responsible for keeping it right, and the result utterly wrong. This system pursued with emery wheels is simply fatal to their chance of success.

Mount an emery wheel on a suitable machine on a rigid foundation (do not put a heavy wheel on a light spindle), run it at proper speed, checking the calculation with a speed counter, keep it always absolutely true with the diamond (a tool not half enough used), press the work lightly on to the wheel—"crowding the work," as it is called, beating more and doing less than gentle pressure; appoint a careful man to use it and make him responsible for its condition; allow him a reasonable time to learn and understand a new tool, and one possessing very great and very unusual power, and the result cannot fail to be satisfaction of the highest degree. But set an ignorant or prejudiced mechanic to a badly appointed machine, with untrue wheels, and expect him to turn out as good work in an hour as he does by other means after years of training, and the result, of course, will be disappointment and condemnation of the unfortunate emery wheel. This may be considered an overdrawn picture; any manufacturer or traveler will tell you it takes place every day. Again, do not commence your emery work by attempting to do something you cannot do with ordinary tools; get accustomed to the new system, and then apply it to the difficult jobs.

Emery grinding can no more be learned in a day than the proper management of a lathe or planing machine. Further, give an emery wheel a fair chance by mounting it properly (at present engineers will pay hundreds for a good lathe or planing machine, yet grudge twenty pounds for a proper frame for an emery wheel), in short, put emery wheels to work they are suited for, be content to spend some time in learning to use them, and the result cannot fail to be as satisfactory in England as in America.

For ordinary fettling and general rough work the simplest, cheapest, and quickest way is to hold the work in the hand against the wheel, occasionally dipping in water to keep it cool, a good wheel not being prejudicially affected thereby. For tool sharpening and grinding a small stream of water under some pressure thrown on to the tool is advantageous, but if much metal has to be taken off in consequence of a deep chip, broken point, etc., it is generally the quickest plan to ignore the temper, grind rapidly, and then re-temper. For really accurate work, of course mechanical feed is essential, flat surfaces being fixed on the traveling table and traversed under a revolving wheel; cylindrical articles are rotated in a lathe, an emery wheel, fixed in a holder in the slide rest, being revolved by an independent strap, and fed against the work to be operated upon. Long bearings are desirable for the high speeds required for emery wheels, but there is no absolute rule as to material; brass bearings work well, as do white metal, and considerable success has been achieved by the new bearing called metaline, a method of treating brasses, obviating the use of oil or any other lubricant. Absolute rigidity, firm screwing home of all nuts, etc., are manifest necessities when high speed is employed.

On the table are specimens of work done by emery wheels, including:

1. Iron and brass castings fettled.
2. Locomotive slide-bars surfaced.
3. Case-hardened crank-pins turned up.
4. One minute slots, in various plates.
5. Circular saw emery sharpened.
6. Shuttle tips.
7. Lathe and other tools.
8. Stone, bricks, carbon, etc., shaped.

A solid emery wheel does not profess to polish; it cuts; and to polish there is nothing to surpass the old leather buff previously described, the elasticity of the leather rendering a very fine polish obtainable, with little or no signs of scratches; but the solid wheel prepares work admirably for the buff, and enables it to be used only for its legitimate purpose, thus causing it to last greatly longer than if used to rough down as well as polish.

Emery wheels may be improved in the future, but as at present prepared they do extraordinary work; the chief field for improvement is in the mechanical appliances to use them in. If an elaborate and expensive machine is required to actuate and utilize a simple point, it is equally required for this revolving file. Some such exist, and I now proceed to project on the screen representations of some of the more interesting English and American machines.

While the essence of emery grinding is high speed, that alone is not sufficient. I exhibit a plate with half-minute cuts made by 12+½ emery wheel and same size grindstone, each running at the same speed (the latter, of course, carefully protected by large side plates), showing in a remarkable manner the difference in cutting power. The respective wheels that did this work are on the table. The first cut shows little difference; but it will be observed, while the emery wheel retains its cutting powers, the grindstone rapidly loses it, until in the fourth and fifth cut there is an enormous difference.

I am sure I am justified in saying that the several firms now engaged in this manufacture in England will willingly give opportunity, at their respective works, to any persons here present, or their friends, to test for themselves the statements and claims put forward on this occasion; and, finally, I trust that the ventilation and discussion of this subject will lead to the more rapid introduction of one of the most wonderful labor-saving inventions since the practical application of steam, with the desire that our own country may keep pace and hold its own proud position in the foremost rank of producers of machinery and general metal work, to the benefit of our manufacturing industries and the increased reputation and profit of both employers and employed throughout the British Isles.

DISCUSSION.

Mr. Arthur Pye Smith (of St. Pancras Iron Works) described several specimens of work which he had placed upon the table, and which had been got up by the emery wheel. This was principally used at their establishment for rougher kinds of work. A great deal was done by laborers and by boys, as, for instance, in cleaning up common cast-iron bars, of which a boy could do from 100 to 150 in an hour. Thin cast-iron also could be reduced by this means when it would not be safe to use a chisel for fear of breaking it, and only recently they had turned out a number of

wrought iron gratings which were finished up by the emery wheel, and which they could not have done at all at the price otherwise. When they first put up the wheels there was a good deal of prejudice against them; but, fortunately, one of their men had used them before, and was therefore put on the job, and in a short time the prejudice was to a great extent overcome, but not entirely. He found the best way was to let the men who were on piecework use the wheels, and then their prejudice soon vanished; in fact, now the men were asking for more machines. He had tried a great many different makes of emery wheels, and found some of them liable to a fault often alleged against them, namely, that they glazed and the work stuck to the surface of the wheel; but that had never occurred with any of Ransome's wheels.

Mr. Wentworth Scott said he could speak to the advantage of these wheels in polishing small surfaces. A short time ago a mechanical dentist submitted several specimens of work to him to examine, to see which were freest from striæ or uneven marks, and without knowing what had been the instrument or tool used in each case, he selected the surfaces which had been cut by emery wheels as superior to the others. Perhaps Mr. Bateman might be able to inform him whether he had sufficient experience of the wheels cemented together by oxychloride of magnesium to be able to say whether they would continue working for a long time without disturbing the vibration of the particles; in other words, whether an old wheel was nearly as good as a new one, or whether any radical change took place, causing a serious difference in its mode of doing its work. He should also like to know whether, in using the emery wheels for cutting magnets, you could avoid the objection, which was formed by any mechanical method of cutting the surface, that it injured the magnetism.

Mr. Sterne (of Glasgow) wished to compliment Mr. Bateman very much on his paper. He was one of the largest emery wheel manufacturers in this country, but he did not know that he had anything to add to what had been so well said. He could confirm what had been said with regard to the prejudice which existed to the introduction of any new machine. About twelve months ago two tool grinders were introduced into a large Government establishment. The two workmen employed upon them immediately complained that they had sore eyes, and wished to go into the infirmary. The foreman was kind enough to put a sheet of glass in front of the machine, but still the next two men had the same complaint. The manager stated that he thought he had one remedy, and that was to order two more machines, and since that time no less than twenty five emery grinding machines have been added by the request of the men themselves. In America emery machines were in use in almost every shop.

Mr. Tepper said he had seen emery wheels used satisfactorily to cut the edges of mill-stones, and he believed they were largely used for this purpose in America. There was a prejudice among the workmen in England, but it was fast being overcome.

Mr. Daniel asked whether the emery wheel was applicable for every purpose for which the smallest file could be used, as, for instance, in cleaning up small cast work, such as a statuette the size of one's middle finger. This would be covered with a great number of small lines, and he should like to know whether emery wheels were capable of removing these in the same way as the small rifflers or files now used.

Mr. Botly thought it was hardly correct to say that a file could not cut anything harder than itself, because in a cutlery manufactory with which he was personally acquainted files were used to shape the different articles. He did not believe that scissors or razors could ever be polished by emery, but must be finished off with crocus.

Mr. Wilson said he would like to make a remark from the engineering point of view. Some eight years ago he had his attention called to emery grinding, and he had two wheels cemented by the oxidized oil process. He found that to grind surfaces mechanically flat, as he wanted, it required a great deal of skill on the part of the workman, and he came to the conclusion that it was of very little use to an engineer unless he had a mechanically moved table, which were not at that time made by any of the emery wheel manufacturers. He therefore abandoned the wheels and made a present of them to his iron-founder, who still used them. Since then he had had some of Mr. Sterne's admirable tool-grinding machines, and was very well satisfied with them. He first had a 15-inch wheel for more than twelve months, and only about an inch was worn off it, and the tools were ground in half the time and at much less expense. Since then he had had a 3-feet wheel, which had only worn away about half an inch in six months, whereas in that time they would have worn out a grindstone costing £3 or £4—

Mr. Sterne having stated that the 3-feet emery wheel would cost £9—

Mr. Wilson said he calculated it would last two or three years, while they used to use a grindstone, costing £2 5s., every four months, so that he should save £7 or £8 on the cost of renewals, besides which the tools got a much finer cutting edge, and he could see the advantage in the cost of the work that was executed. So far as doing mechanical work, such as grinding up a shaft or a crank pin, he did not think they would supersede the lathe until they adopted, in combination with the emery wheel, hydraulic forging, so that as little metal as possible was left to be taken off. If you left a quarter of an inch to be cut off, a steel tool would take it off quite as quickly.

The Chairman remarked that probably the crank pin was shaped first in the lathe, and then, being case-hardened, the emery wheel was used for the purpose of truing up any little distortion which had arisen from the case-hardening.

Mr. Wilson said the sellers of emery wheels professed that whatever could be done in a lathe or planing machine could be done with a wheel. If you employed the system of hydraulic forging, so that the work came out almost clean, then the wheel would answer very well to finish off with.

Mr. McCullagh (North London Railway Works) said the crank pin was first forged and turned, and then case-hardened, and finished on the emery wheel. There was always a little distortion from the case-hardening.

The Chairman asked how the collars were got out. They appeared to have a good radius.

Mr. McCullagh said that the emery wheel was cut to the required shape with a diamond tool.

Mr. Mather (South-Western Railway) explained how the slide-bars exhibited were faced up. They got hollow in working, and used to be got up again with an ordinary copper lap and emery. They were now put in a machine having an emery wheel of 2 inches in diameter and 4 inches in width, which was made to revolve, and had also a side motion to preserve the uniformity and perfect level of the bar. Each bar took about an hour to trim up. They were hard steel, not case-hardened.

The Chairman said he understood that the bar had a longitudinal traverse under the wheel, which had a motion of rotation, and also a transverse traverse in respect of the bar, but lengthways with respect to its spindle.

Mr. Mather said yes. They were traveled rather slowly under the wheel. For the last three months they had used metaline bearings, which appeared to answer very well. Before that they used brass bearings, which wore very quickly, on account of the small particles of emery getting in among the oil and being carried into the bearing by the lateral motion. They had now used the metaline bearing for three months. No signs of wear were perceptible. He was rather skeptical about a bearing without any oil, but the result seemed to be satisfactory. In reply to the Chairman he said there was a considerable pressure on the bearing, because after the work had passed under the wheel once or twice it was screwed down with some force.

Mr. Wilson said he had seen some machinery made by Messrs. Poole—an American firm—for trimming up the cylinders of paper-making machines. They required to be absolutely true, and it was found they could be got up better by an emery wheel than in any other way.

Mr. Blashfield asked if this method was employed at the Aberdeen works for cutting and polishing granite. He believed there was some economical method in use for working it.

Mr. Tepper, in answer to the Chairman, said that both emery and corundum wheels were used for cutting mill-stones.

Mr. Blashfield asked if he referred to French burr stones or granite.

Mr. Tepper said he had seen both cut by the emery wheel. It was done in about one-third the time occupied by hand labor.

Mr. Thomson said the small specimen of moulded stone was very nicely done, but if you were cutting a moulding 18 inches wide, and the emery wheel ground out of shape, how would you keep it in order? He was the patentee of some stone-working machinery, and had seen all the attempts to produce stone mouldings; many of these would do very well for woodwork, but it was the greatest fallacy in existence to try and produce stone mouldings with a tool of corresponding shape; it was like taking a carpenter's moulding plane and telling a mason to plane a stone moulding with it. You might get the tool in the right shape, but it would soon grind out of shape; and you could not produce one or two thousand feet of moulding alike. He agreed that the emery wheel might be useful for stone working, but only by taking a thin wheel, and so controlling it as to make it cut the required pattern. He had patented a machine in which he could use a diamond, emery, or any other tool, and the work was moved up to it by a pair of cams, which never got out of shape, because they were not exposed to wear.

Mr. Bateman, in reply, said the first question asked was as to the effect of vibration on the magnesium wheel. His purpose was not to criticise minutely different kinds of wheels, but to draw attention to the process generally. He did not know what the effect was, and if he did he should not say, because his object was not to push a commercial article, but to bring forward an industrial process. With regard to magnets, his experience had only gone to the shaping of them before magnetization, but his impression was that the process might tend to disturb the magnetism. Magnetism might be induced by striking a bar suspended in a proper position, and very likely the jarring of the emery wheel might have an effect on a magnet. With regard to very small fine work, an emery wheel would not go into corners, nor could you get any rotary tool to perform work with the same degree of delicacy as a fine tool guided by skilled fingers. If it could be used advantageously it would be a very small wheel on the end of a flexible shaft, and brought to bear on the required points, much in the same way as a dentist sometimes operated, by means of a small corundum wheel on the end of a flexible shaft worked by a treadle, which was in truth the parent of the American machine to which he had referred. He should be inclined to agree with Mr. Wilson that the advantage of the emery wheel was not to remove metal by the ton, but by the ounce, although it could be taken off in considerable quantities, and there were occasions in which this would be useful. In brazed tubes, for instance, it was found quicker to grind a lump right off than to stop the machine and chip it. He was obliged to Mr. Tepper for his information with regard to burr mill-stones, which was new to him. He had not had much experience in stone cutting, but he tried some experiments some two years ago in Scotland, and cut a good many feet of ornamental moulding; but the specimen of stone operated on had a very remarkable formation; they occasionally came across a point of some unknown substance which struck fire with the emery wheel like hard steel, and when they came to this hard point the emery wheel got red hot for half an inch. It did the wheel no harm, but he considered this tendency to firing fatal to the process, though no doubt it was due to the peculiarity of the stone. Very probably Mr. Thomson's plan would work better than an ornamental wheel, but a diamond tool, if used properly and sufficiently often, would keep the wheel in any desired shape. You should not wait until it lost its shape before you applied the tool. You wasted the wheel very much less by using the tool freely than by letting the wheel get out of truth and go jumping against the work. With regard to brick cutting, Mr. Reynolds, of Southwark street, had done a great deal of admirable work in this way, and he would advise any one interested in it to consult with him. Granite was dressed very much nowadays; but he did not think it was done with revolving emery wheels, but by hand rubbers of different sections.

THE BLAIR PROCESS.

*On some Recent Improvements in the Manufacture of Iron Sponge by the Blair Process.**

By J. IRELAND, Engineer, Manchester.

THE members of this Institute are no doubt conversant with the process of making iron sponge with which Mr. Blair's name is associated. It will be the object of this paper to describe the improvements which have recently been made in the working plant, and also in the method of treating the ore. The iron sponge reducing furnaces erected at Pittsburgh were designed to work when the ore under reduction took about thirty hours to bring to a metallic state; but in the early part of 1876 Mr. Blair discovered, during some experiments, that by the addition of a small quantity of alkali to the carbonaceous matter mixed with the ore, the action of reduction was quickened to a remarkable extent, and ore which took thirty hours to reduce without alkali could be perfectly done in six hours with it. Subsequent investigation showed that lime in a fallen state answered as well as any other alkali, and on account of its cheapness was most suitable for the purpose. The quantity of lime required being only about five per cent., the extra cost was quite insignificant when placed against the great saving in time. When, however, Mr. Blair came to work the existing furnaces under the new condition of quickened reduction, he found the arrangement could not in any way be altered to suit it. Perhaps a brief description of these furnaces will make the matter more easily understood.

Each reducing furnace consisted of a group of three vertical retorts, each retort being 3 feet internal diameter and about 28 feet high, surrounded by an outer casing of brickwork, leaving a combustion chamber between the inside of the brickwork and the outside of the retorts. The retorts and outside brickwork stood upon a cast iron entablature, supported on columns 12 feet from the ground; below the entablature, and forming a continuation of each retort, were wrought-iron cylinders, each surrounded with a water jacket for more quickly cooling the iron sponge, and having at the lower extremity a sliding sleeve for discharging it. In the top of each retort a cast iron pipe or thimble, 2 feet diameter and about 6 feet long, was inserted, leaving an annulus of 6 inches between it and the inside of the retort.

The retorts were heated externally by gas jets, the air for combustion being supplied through apertures immediately above each jet. When the retorts were thoroughly heated and all in working order, the gas generated from the ore under reduction ascended up the inside of the pipe inserted in the top of the retort, and, on meeting with the air, flamed and so heated the pipe. The ore and carbonaceous matter were fed into the retort down the 6-in. annulus between the retort and pipe, and, forming a narrow column heated on both sides, was thoroughly heated up before reaching the wide retort below. Thus the ore, on entering the wide retort or reducing zone, was all of one uniform heat, both in the center and on the outside, and hence uniform reduction was the result. This initial heating, as it is called, must be done if the ore is to be thoroughly and uniformly reduced. It was this part of the furnaces which would not suit the quickened action of reduction taking place in the body of the retort below; the ore could not be heated up as quickly as the reduction took place, and hence the two did not work in harmony.

After several alterations, Mr. Blair abandoned the system of external heating, and decided to adopt that of passing a stream of hot carbonic oxide through the mass of ore and carbonaceous matter. The writer, however, has since made some improvements in the first-named furnace, which are subsequently described, where the initial heating of the ore is performed as quickly as is possible to be done by transmitted heat, and which is much quicker than the inserted pipe. The new form of reducing furnace adopted by Mr. Blair has several important features. The following is a description of it:

A vertical retort made of fire-bricks, with an external wrought iron casing, stands upon a cast iron entablature supported on columns. The retort is continued below the entablature by a wrought-iron cylinder with water jacket, or, as the writer proposes, instead of one wrought-iron cylinder and water jacket, four small ones are suspended, and thus split up the hot sponge into small columns, by this means effecting the cooling much more quickly. At the lower extremity of each water jacket is a conical mouthpiece and valve, so that the iron sponge can be discharged periodically into any receptacle placed under.

The lower part of the retort from where the gas is admitted is larger than the upper portion. This is done so as to form an overhang immediately above the aperture where the gas is admitted, thus forming a chamber round the mass of ore, etc., and allowing the gas to permeate it uniformly. At the top of the retort is an outlet for the escape of the gas after passing through the ore, which is connected by a horizontal pipe to a vertical one descending to the ground, and there connected to the chimney flue. In the horizontal pipe above named a steam jet is inserted, so as to form a vacuum in the top part of the retort, to induce a regular current of gas through the ore, etc. The retort is fed by an ordinary bell-hopper.

The carbonic oxide is generated in a gas-producer placed a few feet from the reducing furnace, and connected to it by a flue of sufficient capacity. The gas-producer is circular in section, formed of wrought-iron plates, lined internally with fire-bricks, and standing on an entablature, which, in turn, is supported to the requisite height by columns of brickwork. Below the entablature, and suspended from it, is a wrought-iron continuation, tapering to a conical discharging valve for allowing the ashes to be from time to time removed.

Apertures for admitting air for combustion in the gas-producer are placed in its circumference, fitted with slide covers to regulate the admission of air.

Mr. Blair, having made arrangements with the proprietor in America of the Ponsard producer, used it in preference to the ordinary Siemens one, as the admission of air is more easily regulated. The writer has used one of the circular ones described, and finds it answer the purpose equally as well as the Ponsard. The object of using a carbonic oxide gas is primarily to supply heat to the ore, etc., to be reduced. What reduction is effected by the gas is a secondary matter; and in this point the process differs from other attempts where carbonic oxide has been used solely for reducing the ore. It will be seen that in using the steam jet to induce a stronger current of gas through the ore under reduction, the temperature in the gas-producer will be increased, and the gas in time become hotter than required, the result being that the mass against which the gas impinges in the reducing furnace, being almost entirely metallic, would become welded together, and so interfere with the regular working of the furnace. To obviate this, a very simple and ingenious arrangement has been made by Mr. Blair, by which the temperature of the gas can be kept at almost one uniform heat. The gas, after passing through the reducing furnace, is still almost entirely carbonic oxide, and on passing by the steam jet becomes mixed with steam; in order to condense it a water spray is introduced at the top of the descending flue to the chimney. A little above the air apertures in the gas-producer are two pipes connecting it and the descending flue, so that some of the gas which has already passed through the reducing furnace can be again sent through the gas-producer and used over again, and at the same time cool down its temperature. By regulating the slide covers of the air apertures in the gas-producer and the damper in the flue to

* Paper read before the Iron and Steel Institute.

the chimney, an equal quantity of air and gas can be supplied to the producer. It is found, in practice, the two can be so regulated that an almost uniform temperature can be maintained in the reducing furnace, and a saving effected in fuel; in fact, by the cooling action of the return gas, any temperature can be obtained. The reducing furnace just described will reduce about 200 tons of ore to a metallic state weekly, the dimensions of the retort being 5 feet diameter in the upper and 6 feet 6 inches in the lower part, by 16 feet in height. The height of the whole structure is 36 feet, and the cost about £700.

The fuel used in the gas-producer is coke; and if the iron sponge made is intended for steel-making, the coke should not contain more than ·75 of sulphur—the less the better—otherwise the iron sponge will be affected by it. But where pure ore can be had, and coke from washed coal not containing more than the above-named amount of sulphur, this form of reducing furnace is undoubtedly the best for producing iron sponge in large quantities, and the whole of it thoroughly metallic.

In the autumn of last year the writer was requested by the Indian Government to reduce some of the iron ore of which there are large deposits some fifty miles distant from the Warora coalfields, the condition being that the ore must be reduced with Warora coal, a quantity of each having been sent over here from India. The ore is magnetic, very rich and pure, containing over 70 per cent. of metallic iron. The coal, on the other hand, is very poor, being a black lignite, containing about 15 per cent. of ash and 10 per cent. water, besides a great number of sulphur pyrites, and it will not coke. From the nature of the coal, it was evident the form of reducing furnace last described, where the heated gas was passed through the ore, was not suitable, and therefore the old form of furnace must be used, in which the heat is transmitted through the retort; but here again some different arrangement must be made to heat up the ore more quickly. The writer ultimately concluded to abandon the inserted pipe or thimble, and divide this part of the retort into a number of smaller ones, so as to present as small a column of materials to the action of the heat as possible. A small furnace, some 21 feet in height over all, was erected on this principle, with a reducing retort about 18 inches diameter and 10 feet 6 inches high, and a cast-iron pipe on the top 8½ inches diameter to heat up the ore. This furnace works well, and has been in constant operation since September last. Some twenty tons of the Indian ore have been operated on, and iron sponge of uniform and excellent quality produced, part of which has been since made into first-class tool steel, and some of it melted in a cupola into pig metal. The Indian Government are so far satisfied with the experiment that the question of erecting works on this principle for the manufacture of iron and steel in India is now under consideration by the Council. Various other ores have been reduced in this furnace with the same uniform result.

Though of small dimensions, this reducing furnace is on the principle proposed for working with transmitted heat; and in furnaces of larger diameter, the number of small heating retorts, placed on the top of the larger or reducing one, will be increased as the diameter of the latter increases: thus a reducing furnace of 3 feet diameter will have four small retorts above it, and 5 feet diameter will have seven. The top of the large retort is arched over against a circular key-brick, having a hole through its center, one of the small retorts standing on the top of it. The remainder are placed round, each resting on two of the arches, so that the ore, etc., when heated, falls down between the arches into the large retort below. The spaces between the arches being almost square, and the small retorts round, a space is left at each corner, through which the gas generated from the ore under reduction can escape into the combustion chamber round the small retorts, thus helping to heat them. To cool the iron sponge as quickly as possible after reduction, it is split up into three or more columns (according to the size of the furnace) in the wrought-iron cylinders below, each cylinder being surrounded by a water jacket, through which a slow current of cold water is passed; and on being discharged from the mouthpieces is sufficiently cool that oxidation does not take place. A reducing furnace of this description, 5 feet diameter and 40 feet high, will reduce sixty to seventy tons of ore to a metallic state weekly, and the cost is about £600.

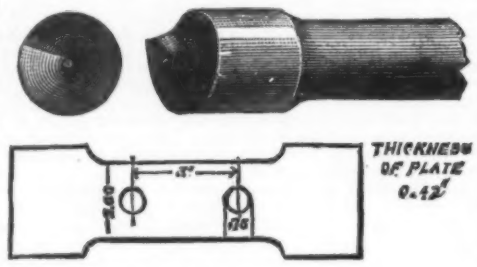
The cost of producing iron sponge by this process will vary according to the locality in which the work is carried on, but, with the large reducing furnaces mentioned, the cost will be about 22s. per ton, exclusive of the ore. It is, however, confidently expected that, where several of the furnaces are in operation, the cost will be less. The question of the subsequent use of iron sponge is an important one. Where the ore is rich and pure, iron sponge made from it can be at once made into tool steel, the quality of which cannot be equaled by that made from the best brands of Swedish bars. In the case of ore which is not so rich, but still suitable for steel-making, the writer is of opinion the best way of utilizing the sponge made from it is to melt it in a cupola furnace into pig metal, and while in a molten state pour it into a Siemens-Martin furnace, and in this way convert it into steel. The pig metal obtained in this manner will contain about 1·5 carbon and practically no silicon, the greatest amount of the latter yet found by analysis being 0·25, and the lowest 0·19. If this metal is poured while molten into an open hearth furnace as proposed, there ought to be no serious difficulty in getting six heats from each furnace in twenty-four hours, in place of the two or three heats now obtained. Iron sponge melts readily in a cupola furnace, and the risk of oxidation is less than when it is thrown into a bath of pig iron in an open hearth furnace. The same remarks apply to the manufacture of wrought iron. From the nature of the particles of iron in iron sponge being so minute, it cannot be balled up in an ordinary balling furnace without considerable oxidation; on the other hand, if melted in a cupola furnace, the resulting metal, containing so little carbon and silicon, if taken in a molten state from the cupola to the puddling furnace, very little rabbling brings it to nature.

The molten metal can be made almost as cheaply as pig iron; in fact, there is no reason why it should not be made as cheaply. The first outlay in plant and the wear and tear are reduced to a minimum. To produce 100 tons of the metal per week, the cost of plant will be about £2,500—two reducing furnaces, two cupolas, fan or blower, small engine and boiler, hoist and ore breaker, being all that is required. There are many points not touched upon in this brief and somewhat imperfect description of the process and apparatus, but the question is one worthy the consideration of iron and steel makers.

With regard to the action of the lime in accelerating the reduction of the ore to a metallic state, it certainly is a great help forward in the manufacture of iron sponge. What its chemical action is has not been clearly demonstrated; but it is remarkable that so small a quantity of it should produce such a great acceleration. Perhaps some of our chemists can explain the phenomenon?

IMPROVED SPIRAL PUNCH.

THIS punch is so formed as to cut its way through the iron with a shearing action, which, it is alleged, does not tear or injure the iron like the ordinary blunt punch. The results are very remarkable. For example, steel boiler plates of the form shown in the figure below but with only one hole in the center, punched with the common punch, had a



tensile strength of 38,579 lbs.; a similar plate, punched with the spiral punch, had a tensile strength of 63,929 lbs. When two holes were punched as above with the common punch, the plates broke at the holes in every case, but remained firm under the new punch, which also requires less power to make a hole of a given size. It was lately presented to the Iron and Steel Institute as the invention of Mr. Kennedy, by Thompson Sterne & Co., London.

THE INVENTION OF THE REAPING MACHINE.

IT has always been a point not quite decided whether the Scotchman Bell or the American McCormick was the first to construct a practicable reaping machine. The evidence appears to be strongly in favor of Bell, whose apparatus was in use from about 1826 to about 1850, shortly after which time it was purchased by Mr. Woodcroft for the Patent Office Museum. Mr. McCormick, on the other hand, may fairly claim the credit of having been the first to bring a reaping machine into anything like general use, and there seems no doubt that the machines of our own time are the descendants, not of Bell's forgotten apparatus, but of the machine brought forward by McCormick at the 1851 Exhibition, and patented by him seventeen years before in the United States (1834).

It is, of course, well known that many other inventors had previously attempted to gain the desired object by means more or less effectual. Revolving cutters were tried as far back as 1799, while two inventors at least * (Salmon, 1807, and Ogle, 1822) had reciprocating knives, or frames fitted with knives, which resembled, to a certain extent, the cutters now used. These last had, however, no shearing action, and it is precisely this shearing or drawing cut that alone answers for cutting corn. Such an action is found in Bell's and in McCormick's machines, but there now seems some reason to believe that both these were anticipated by John Common, of Denwick, Northumberland. The following extract from the old MS. Committee Minutes of the Society of Arts does not appear to have been seen by writers on the subject, and it almost certainly has never been printed. The extract is from the minute-book for the Session 1811–12:

"Took into consideration a reference to this committee of April 15th, 1812, on a reaping machine. Read two letters from Earl Percy, dated 8th and 14th April, 1812, stating that he had sent to the Society the model of a machine for reaping corn, barley, oats, etc., made by John Common, of Denwick, Northumberland; that he is not quite certain whether a sufficient trial of the machine has been made to authorize its being laid before the Society, as the inventor, Mr. Common, partly from the fear of any person stealing his invention and partly from the want of more extensive means, did not cut more than ten or twelve sheaves, but in this experiment the machine acted with great precision; that the two persons who assisted Mr. Common are the only persons who have seen it act and have sent certificates respecting it.

"Read a certificate from John Thew and Thomas Appleby, dated Denwick, April 9th, 1812, stating that they accompanied John Common to a field at Denwick, to make trial of his newly-invented reaping machine, where they saw it cut down a small patch of ripe oats with ease and dispatch, and that they are of opinion it will answer the purposes intended, and be of general benefit to the country.

"Examined the model sent. The apparatus is to be drawn by one or more horses, and is of considerable length; it appears that the two large wheels, from whence motion is given to the machine, are to be made of wood and iron spikes fixed in their periphyræ; they are fixed upon an axle of iron which moves round with them, and which axle also turns round a brass wheel fixed upon it, the teeth of which work in a pinion placed on a longitudinal axle. On the other end of the spindle or axle near to the shafts is fitted another cogd wheel, the teeth of which work in a pinion below supported by a small wheel to prevent this part of the machine from touching the ground. The pulley and pinion last mentioned give an alternate backward and forward motion to a set of angular knives, so as to enable them to act upon a principle similar to the action of a number of scissors upon the blades of corn, directed to them by angular spikes of iron projecting before them as it falls upon a set of rollers, from whence it is delivered in a line upon the earth, as described in an account sent with it.

"Resolved, It appears to this committee, upon inspecting the model of Mr. Common's reaping machine, and reading the account thereof with the certificate produced, that this invention is incomplete, and at present they cannot fairly judge of it, and therefore cannot recommend it to the further attention of the Society."

The description is certainly somewhat meager, but as far as it goes it is sufficient to show that the main principle of the reaping machine was known and had been experimented with at least thirteen years previous to the date generally allotted to the invention.

Another machine brought before the Society of Arts, but apparently not elsewhere mentioned, is one by Amos, of Boston, Lincolnshire. In it "a number of scythes are caused to revolve rapidly by the usual adaptation of wheels and pinions." The committee had this brought before them in 1820, and decided that "the plan, however, was not new, and it has been found by experience that it is impossible to apply to this construction power enough to produce a sufficiently rapid motion of the scythes."

Bell's machine came before the Society in 1830, but was not rewarded, on the ground that the descriptions of the machine already extant had brought it sufficiently before the public, and that it did not therefore require the Society's aid in bringing it into notice.—*Journal of the Society of Arts.*

* See Appendix to Specifications of Reaping Machines. By B. Woodcroft, 1853.

CORROSION OF IRON AND STEEL.

AT a recent meeting of the Iron and Steel Institute, Mr. Henry Bessemer stated that he had prepared three bars of ordinary wrought iron, 2 inches square and 1 foot in length, and prepared three bars of cast steel of different makes of the same precise dimensions, and in order to have the precise amount of surface exposed they were carefully planed in the planing machine, and smooth-filed in every angle left square—the ends left bare—and then carefully weighed in an accurate weighing machine, which would determine to 1 or 1½ grain the weight of those large bars. Those bars—three of iron and three of steel—projected from a bar of wood 10 inches downward. A small trough was prepared in which water, with a small quantity—he thought about 6 per cent.—of sulphuric acid, as a corroding material, was placed. That bar of wood with its projecting pieces downward was immersed in that preparation, and taken out once in every ten hours for forty hours, to examine the state that each bar was in, and then replaced, so that one might see how much in weight was dissolved from each bar under operation. He might tell them that at the end of forty hours the steel bars had lost a notable portion of the metal, so much that they could feel the point between the water-line and the corroded part. Some of those bars of steel had suffered from here and there a bubble-hole in the surface; and those little black lines that they all knew so well and disliked so much appeared on the surface as little elongated slots, as showing the piercing of the fluid into the particular interstices of the steel, so far as the few cracks or elongated air-bubbles were concerned. The three iron bars were so corroded that on the flat side of the pile they exhibited a sort of slightly undulated surface. On the sides of the pile there were five separate welds shown, five grand separate weldings, and an infinite number of little weldings; but five main points were shown absolutely upon it, and the blade of a penknife would go in to the extent of ⅛th of an inch all the way round. The most curious fact was seen on the end of the bar; the end of the bar looked, he should say, as much like an old clothes brush with black bristles as anything they ever saw. It was pierced endways, varying from ⅛th to ¼th of an inch, so that a needle or any other small point could be pushed up into it every way or any way, showing how corrosion varied in the pile, and exhibited a much larger surface, though the diminution of the bar of steel and iron was such that the iron gradually began to exhibit a greater surface, and therefore more rapid corrosion. His memory did not serve him, but he could supply the fact at another time; he believed the worst iron bar of the three had lost twice and a quarter of the amount of weight in the forty hours as that corroded in the steel bar in the same solution and for the same number of hours exposed; indeed, the way in which corrosion takes place in bar iron was exhibited in all those things that were constantly exposed to the action of corrosion and brightened. He should say that a very familiar object to many of them was a street pump handle. Every one who had taken hold of the iron handle which had been exposed for some ten or twelve years to the ordinary weather would know that the originally round piece of iron had got into a long reedy piece of iron—long lines that stuck up, and certain deep depressions worn away—that was evidently the corrosion taking place in certain lines much more rapidly than other parts. He thought there was no doubt that under the ordinary condition of acid or fluid, wrought iron would be found to be more corroded in a given length of time than a piece of steel.

THE MERCHANT FLEETS OF THE WORLD.

WE learn from the *Bureau Veritas* that the total number of sailing ships in the civilized world at the end of 1877 was 51,912, divided as follows:

	Ships.	Tons.
England	17,765	5,526,930
United States	6,307	2,146,731
Norway	4,135	1,352,949
Italy	4,402	1,296,985
Germany	3,140	876,814
France	3,300	666,767
Spain	2,744	550,533
Greece	2,024	419,418
Russia	1,802	417,973
Sweden	1,941	402,248
Holland	1,268	366,284
Austria	652	253,730
Denmark	1,203	182,870
South America	355	129,901
Portugal	441	106,215
Turkey	300	50,101
Asia	51	21,079
Central America	57	18,546
Belgium	25	13,033

Of steamships the numbers are as follows:

	Steamers.	Tons.
England	3,133	3,283,911
United States	542	674,036
France	272	319,179
Germany	220	259,785
Spain	224	176,310
Holland	110	112,879
Russia	145	105,011
Italy	110	95,305
Sweden	210	87,280
Austria	74	83,540
Denmark	96	64,677
Norway	122	54,649
South America	83	58,649
Belgium	25	35,471
Turkey and Egypt	33	30,467
Asia	22	29,314
Portugal	26	22,580
Central America	13	10,152
Greece	12	7,621

ALBERTITE.

By JAMES MACFARLANE.

NEW BRUNSWICK, Nova Scotia, possesses a mine of a new and beautiful substance, analogous to coal, called Albertite, which is deserving of notice at least as one of the curiosities of our subject. It is situated at Hillsborough, on Peticodiac River, in Albert County, near the head of the Bay of Fundy. Albertite is used in the manufacture of oil and gas, yielding one hundred gallons of crude oil per ton, or 14,500 cubic feet of gas of superior illuminating power. It was discovered in 1849, and there were 56,289 tons of it exported to the United States in three years, from 1863 to 1865.

Unlike coal, it is found in a true vein, or filling a crevice in the rocks, and most authorities now agree in considering the substance as a variety of asphalt, or a solid hydrocarbon, originally fluid, like petroleum, and derived from the decomposition of vegetable or animal products. Formerly it was regarded by different authors as a true coal, an asphaltic coal, and a jet. It is a new material, intermediate between the most bituminous coals and the asphalts, and is found in the lower carboniferous formations. It has a beautiful and singular appearance, having a resplendent resinous luster, a perfect conchoidal fracture, and it is perfectly free from mineral charcoal and lines of impure coal or earthy matter. It is, however, divided into prismatic pieces by a great number of smooth, divisional planes, proceeding from wall to wall.

Albertite coal (or solidified petroleum, as it is sometimes improperly called) is also found in Ritchie County, West Virginia, where it is called grahamite or Ritchie mineral.

According to official documents of Canada, the following are the shipments of albertite for the twelve years from 1863 to 1874:

1863	18,600 tons.
1864	19,300 tons.
1865	20,500 tons.
1866	20,500 tons.
1867	17,000 tons.
1868	12,400 tons.
1869	17,000 tons.
1870	6,000 tons.
1871	5,500 tons.
1872	5,000 tons.
1873	6,000 tons.
1874	7,000 tons.
Total	154,800 tons.

Calculated from the royalty paid, there were mined before the year 1863, 22,492 tons, making the total production 177,292 tons since the discovery of the albertite in 1849.

The marked decrease in the amount reported since 1869 has been due partly to extensive fires in the mines and partly to a great diminution in the size of the vein. It varies from one to fourteen feet in thickness, and is placed almost vertically in the ground. It has been mined to a depth of 1,162 feet.—*Coal Trade Journal.*

THE WASTE OF GASLIGHT.

EVERY industrial process, chemical or mechanical, must be followed by a certain amount of waste or loss, either of material or power. The products obtained by a chemical process never exactly coincide with the theoretical formula, nor can work done mechanically equal the power applied. The loss sustained in the manufacture of illuminating gas, from the very beginning of the process till it flows from the burners, is due to chemical action that it is almost impossible to avoid, and to mechanical imperfections causing leakage—a source of loss that can be to a certain extent remedied by less carelessness on the part of those who are concerned in its manipulation, distribution, and use. About fourteen per cent. is said to be the average loss incurred in the manufacture and burning of ordinary gas, or that which represents the actual discrepancy between the theoretical and practical results. A portion of this loss, or that occasioned by imperfect and leaky joints, worn-out or badly-constructed burners, is followed, of course, by "outrageous gas bills" and a consequent grumbling of the consumer. Now all this waste that we have spoken of thus far concerns the *material* only—the *gas* itself; but there is another side to the question of large gas bills, one that has been little thought of, and one that may be considered new—and this concerns, not the waste of gas itself, but the waste of gas *light*. This is a subject that directly interests the consumer, for it is safe to assert that one-quarter of the whole of the gaslight produced in places of worship and public entertainment, as well as in private houses, is wasted, and it therefore remains with consumers, and them only, to remedy the matter.

Before indicating some of the ways in which this waste takes place, and how to remedy it, let us consider a few of the physical properties of light.

Light, the medium through which everything beautiful, or otherwise, is seen, diffuses itself equally on all sides from its source (though not quite, but nearly so, in the case of a flat gas flame). It is well known that light lessens in intensity the further we remove from its source; a gas flame, casting a given amount of light on an object, say at a distance of one foot, will throw only one-quarter of the light on the same object if the distance be increased to two feet, and so on, as the square of the distance increases. Light cannot be caught and *weighed*, but it can be caught and *reflected* in an endless variety of ways. It is also *absorbed* by the objects upon which it falls. A dull, black object absorbs all the light thrown against it, and reflects none; and a white object reflects nearly all, and absorbs little; while absorption takes place in all proportions between these two extremes. All colored surfaces absorb light, and they do so in proportion as the shades are darker or lighter. A glazed surface always reflects more than a dull one of the same color.

Remembering these properties of light will assist us in understanding what follows. The main sources to which we must look for a waste of light are three: 1. *Character of interior decorations;* 2. *Distribution and position of light sources;* and 3. *Appendages* (either for ornament or use) *to chandeliers.*

First of all, the wall-papers and furnishings of our living-rooms and places of public resort have a great deal more to answer for than one would suspect. It is no unusual thing for wall-papers to be used in dining and other rooms, and wall decorations in public places, which will *absorb* 90 *per cent.* of the light thrown against them, and *reflect* only 10 *per cent.* back in the room. Other papers are used which absorb not more than 15 per cent., and reflect back for further use 85 per cent.; but, strangely enough, these are put into places which are least used, such as drawing-rooms and bedrooms. The difference between the dark paper, which absorbs 90 per cent. of the light, and the light paper, which absorbs only 15 per cent., is 75 per cent. against the dark one; but this does not represent the extra light which will be required to bring up the illumination of the darkly-papered room to that of the lightly-papered one, for this reason—a wall of the lightly-papered room will reflect to the opposite wall 85 per cent. of the light it receives; 85 per cent. of this will again be reflected across the room, leaving 72 per cent. of the original light unabsorbed after two contacts with the wall, and so the process goes on until the diffused light in the lightly-papered room is increased to a considerable extent. In the darkly-papered room 90 per cent. of the light is absorbed in its first contact with the wall, 10 per cent. only being reflected to the opposite wall; and after this second contact 1 per cent. is all that remains of the original quantity, as compared with 72 per cent. of the lightly-papered room. At the present day it is scarcely possible to find in the better class of houses a living-room with four white-washed walls and ceiling; but it may be easily seen how much less light it takes to illuminate a lightly-papered drawing-room than a dark-papered dining-room. Of the latter there are thousands, which, with all their expensive papering, are worse lighted with their five-light chandeliers than are most of our whitewashed kitchens with their one naked flame. This light-absorbing power of colored surfaces explains why we have so many dark corners in our houses and so many gloomy places of public assembly. It also explains why a large room can be lighted with a much smaller number of lights, in proportion to its area, than are usually required for a small one.

It is apparent that where light and cheerfulness, to say nothing of economy, are desiderata, light colors for interior decoration should be the rule; that the use of these admits of elegance of design, there are plenty of drawing-rooms in our midst to bear witness.

Pursuing the consideration of the question still further, we will note some of the sources of waste (to be observed mainly in places of public resort) through the bad distribution and bad location of chandeliers and gas jets.

The systems (or, we might more truthfully say, *want* of system) of lighting churches and places of amusement are so varied that it would be impossible to call attention to the merits or demerits of each; but there is one thing that cannot fail to have been remarked by every one—the great number of places of public assembly that appear so dim and gloomy, and yet which appear to be supplied with gas jets to a degree that might seem extravagant. The want of light in these cases is usually ascribed to "poor gas." Some churches we find lighted by gas jets placed on the tops of pillars six feet high, rising from the pews, in the body of the church; while the galleries are lighted by a tier of lights placed three pews down, an arrangement by which the light, instead of falling on the books of those sitting in the top pews, shoots into their eyes and almost blinds them. Lighting by pillar-jets is said to be very economical, but it has the grave fault of placing too many points of light in the line of view of those sitting in the pews furthest from the pulpit. In some churches, the body of the church, the inner circle of pews, and the gallery side pews receive their light from a large chandelier hung from the ceiling. In many cases this is hung too low, thus giving more than sufficient light to those beneath it, to the inner circle at the bottom and in the gallery, while the two top tiers of pews on either side of the gallery are miserably lighted—the light shooting into people's faces and over the tops of their books instead of falling upon them. The result is seen in the occupants of such pews turning their backs on their pastor in order to get the light they require. Again, we find places of amusement or instruction lighted by chandeliers hung so high that they serve only to illuminate the ceiling; and this is not all, for very often three-fourths of the burners are so placed on the chandeliers that they produce no appreciable illumination on the audience. All the inside lights only serve to illuminate the chandelier itself, which possesses no power of reflection to transmit the light where it is needed; and the lower interior lights, in addition to being useless for giving light, shoot their products of combustion up to the lights above and keep them in a constant dance.

The foregoing are but a few instances to show how money may be spent in wasting gaslight.

The most serious source of waste of light takes place in our own homes, in the pieces of apparatus connected with our chandeliers, brackets, etc. These appendages are an outgrowth of the demands of modern taste, and consist of globes, coronets, globe-holders of various thicknesses, and sundry pieces of metal, called ornaments, under the globe-holder.

The globe is an article that can scarcely be called anything else than an ornament; and, before making use of such an ornament, the public ought to know what the effect is going to be. A globe of clear glass obstructs from 10 to 15 per cent. of light; ground glass, from 25 to 40 per cent.; and from that to clear glass the loss is in proportion to the amount of ground or figured surface on the globe. Opal globes obstruct from 35 to 60 per cent., according to the thickness of the glass, but give a good downward light if the opening be large and the holder light and free from ornament underneath—not otherwise—and are pleasant to look at. The idea of increased light, which some receive when first entering a room where these globes are used, is the result of an optical illusion. If the "glare" of light is to be modified, ground glass will do it with less loss of light than opal, but the under part of the globe should always be clear, so as to allow a free passage for the light downward.

If globes are to be used at all, those should always be selected having openings as large as possible at the bottom; the old practice of making the diameter of this part two inches and under is ridiculous and utterly inadequate for its present requirements. For a globe-holder nothing is needed but the three forks, as light as possible, projecting from the center, and furnished with the necessary screws. We want no thick nor thin metal rings around the globe-holder, nor saucer-shaped pieces of metal under it, nor anything that will obstruct the downward light to the desk or table, or cast a shadow in any direction.

The coronet is one of the worst gaslight wasters, compared with any good that there is in it, that we can use. It is supposed to prevent the ceiling being smoked, and so it does to a small extent immediately above the burner; but what it saves in this respect is simply distributed over a larger area. The effect of using it is to obstruct the whole of the top light and cast a pale-like shadow over the room. It reflects a little light, but it is an infinitesimal amount compared with what it obstructs.

The question of waste of gaslight and the remedies for it that we have here briefly considered is not one simply of dollars and cents, but one that has an importance in a sanitary point of view; for the less gas we burn to make our living-rooms bright and cheerful, so much the more life-giving oxygen is left unconsumed for our own breathing. And this is the more important from the fact that properly-ventilated houses are altogether too rare with us.

PAINT IN CONSTRUCTION.

By ROBERT GRIMSHAW.

AFTER the designing and making of any structure comes the question of maintenance from accident and gradual internal and external deterioration. The most important mode of preventing external deterioration is by means of coats of "wash," varnish, paint, etc. Such coatings, properly applied, generally both add to sightliness and protect from impairment. We shall here consider what are ordinarily known as paints, generally consisting of some solid base or "body," dissolved or "ground" in a menstruum or vehicle.

The most common white "bodies" are lime, Paris white, white lead, zinc white, sulphate of baryta, and asbestos. Iron peroxide, antimony, vermilion, and "red lead" give reds; chrome and ocher earths, yellows; Prussian blue and smalt, blues; the oxide, carbonate, and arseniate of copper, greens; lamp-black, coal, and some of the residual products of shale-oil distillation, blacks; while hydraulic cement gives grays. Suitable combinations of these produce the other colors and shades.

The most common menstruums are water, glue, and other "size," raw and boiled linseed oil, nut, poppy, and fish oils, and water-glass.

The principal matters to be considered in paints are their resistance to the action of air, heat, cold, dust, light, fresh and sea water, alcohol, grease, steam, sulphurous and ammoniacal compounds, acids and alkalies, and abrasion, thin color, hardness and brilliancy, flexibility, ease of application, quickness of drying, special uses, covering power, and cost.

Lime is used, mixed with water, and applied either as "whitewash" or in "fresco" painting. The latter, however, has no bearing upon paint as a protective material, but the former acts admirably as a protector of wood in many cases. Lime cannot be decomposed by the highest heat.

Plain lime-wash has been satisfactorily used on smoke-stacks, where the linseed oil paints char and peel off. It is good and durable for the inside of water-pipes and tanks. The celebrated "White House Whitewash" is made as follows:

Paris White, or whiting (so-called Spanish white,* chalk, soft carbonate of lime), does not mix well with oil, giving no luster and no durability. It works well, however, with glue-size (forming so-called "calcimine"†), which may be given a luster by a coat of varnish. This pigment is used only for interiors of buildings, resisting quite well the action of air, light, heat of dwellings, etc., but not withstanding that of water.

Washed chalk is most frequently used as an adulterant of white lead. An "anti-corrosive" paint is made of equal weights of whiting and white lead, to which is added half the quantity of very fine sand or road-dust. It may be used as a water or an oil color; in the latter case the best vehicle being 12 parts of raw linseed, one of boiled, three of sulphate of lime (plaster of Paris), using one gallon of the oil to seven pounds of the color.

White Lead, the basis of most paints, is the basic carbonate of lead;‡ generally, on account of defects in manufacture, largely mixed with the hydrated oxide. It is a heavy, chalky powder, white in color, becoming grayish from the action of ordinary air; brown or black from sulphureted hydrogen; insoluble in water or alcohol; effervesces with cold hydrochloric acid; hot hydrochloric acid dissolves it, forming chloride of lead. Dilute nitric acid dissolves it easily, with effervescence of carbonic acid gas. Heat yellows it permanently, forming "massicot." It neither injures nor is injured by other colors. Damp air injures it. Age improves its quality.

Messrs. Wisner & Harland state in a paper read before the Society of Public Analysts that the presence of about 25 per cent. of the hydrated oxide is *necessary* in order that the mixture may form a compound instead of an emulsion, and possess both the powers of laying on readily and easily, and, by its opacity, hiding the color beneath. They state that paint made of *pure* carbonate of lead never really dries or hardens or becomes a "full-paint" (perfectly obscuring the color beneath), and that it becomes pulverulent, and is easily rubbed or washed off.

Zinc White, the oxide of zinc, is insoluble in water; hydrochloric acid dissolves it with slight effervescence of the carbonic acid gas absorbed from the air. Heat yellows it, but only while it is heated. When fresh, it is soluble in the alkalies; also in concentrated sesquicarbonate of ammonia. The dry zinc white is brilliant, white, and fine; it is ground in about the same menstruums used for lead. After mixing and applying it becomes hard enough to take a polish; sulphurous gases do not blacken it, because the sulphide of zinc which they form is also white. Weight for weight, it covers 33 per cent. more surface than white lead, but it is not so opaque as lead, and is dry under the brush, and hence hard to apply; is long in drying; when adulterated is apt to change color. As it has no smell, rooms freshly painted with it may be occupied without injury to the inmates from the zinc. Like lead, it has the advantageous quality of forming an oleate with the oils, although it does this slowly. It is the best coating for zinc. It retains its color even in the hold of a ship. It is adulterated with sulphate of baryta and with sulphate of lime.

Baryta White (heavy spar, sulphate of baryta) is handsome, innocuous, fast, and resisting most agents. It has little covering power. It is generally used as an adulterant of white lead. What is known as "Venetian white" has ¼ heavy spar; Hamburg white, ⅔; Dutch white, ¾. These generally have a thin yellowish tinge somewhat contracted by charcoal, indigo, or Prussian blue. In Austria the pure sulphate of baryta is called "Tyrolese white lead." It forms a slow but intimate combination with the soluble alkaline silicates, and with these salts forms pigments of beautiful luster, entirely unaffected by sulphureted hydrogen.

Blende, or sulphide of zinc, could be advantageously substituted for white lead or for zinc white covering as well as these, and flowing more readily under the brush, being fast and durable, and not changing other pigments with which it is mixed. Its only disadvantage is that it is not pure white.

* The *real* "Spanish white" is a *bismuth* precipitate.

† True kalsomine is made of kaolin and skim-milk.

‡ See article upon Manufacture of White Lead, *Polytechnic Review.*

Antimony White (oxide of antimony) is not unhealthful, and has twice the covering power of white lead. It could be cheaply made from natural sulphide of antimony at less cost than lead.

Iron Oxide (sesquioxide and hydrated sesquioxide of iron, red and brown hematite).

What is generally called iron oxide is generally a clay (or chalk), colored with — to — per cent. of iron oxide, and ranging from yellow to brown in color, and in weight accordingly, the lighter shades being unaffected by the magnet. With this inferior material the oil is liable to be absorbed from the iron oxide and the whole to change color and peel off. But "magnetic paint," or pure iron oxide, is excellent as a protection from iron, it being sometimes impossible to scrape it off; excellent on woodwork. It is resistant of salt water. It stands sulphurous gases well. If good, it covers better than red lead. It is resistant of fire; applies and stays well even on slightly-rusted plates; is good on steam pipes.

Red Lead (proto-sesquioxide of lead, P_6O. P_2O_3) is unaffected by water. Hot hydrochloric acid forms with it chlorite of lead, chlorine being given off. Dilute nitric acid dissolves it, leaving a brown powder.

Its extreme durability makes it especially valuable as a priming (often the only coat applied) on ironwork.

To get red lead and linseed oil paint to adhere to gasholders, it is well to heat each sheet and plunge in hot linseed oil. Red lead on the bottoms of iron vessels is, *unless freshly mixed*, not as good as iron oxide paints, forming "ulcers;" it also discolors.

Prussian Blue (ferro-cyanide of iron) is insoluble in water and in alcohol, and in dilute acids (except oxalic); alkalies decompose and bleach it; it is decomposable by heat; it is the most intense of all blues, but has little permanence. The principal adulterants are alum, oxide of iron, starch, carbonate and sulphate of lime, alumina, and sulphate of baryta.

Good Prussian blue should be light in the hand, adherent to the tongue, and give a smooth, deep trace. If it effervesces with acids it doubtless has chalk in it; certainly some carbonate. If it become pasty with boiling water, starch is probably present. Sulphureted hydrogen whitens it; old damp walls destroy the color by the nitrate of lime they contain. It would be desirable to apply metallic zinc itself, but it is difficult to levigate it. The addition of about $\frac{1}{70}$ of iron makes this possible, thus giving paints by which we could in a measure "galvanize" with a brush.

Cobalt Blue (Thénard blue, subphosphate of cobalt) is a handsome pigment, very durable, becoming more intensely colored in the air; resists fire, acids, and alkalies.

Smalt (zaffer blue, cobalt glass) is a double silicate of potassa and cobalt, mixed with lime, alumina, magnesia, oxides of iron and nickel, etc. It is hard to grind fine; turns green and black on inside work; dries rapidly; changes less in size than in oil.

Coal-tar is an excellent preservative of iron, not cracking or permitting of rust. Sanding after coating relieves the somber blackness. Cast-iron water-pipes should be cleaned, heated to 300° F., and dipped in melted coal-tar pitch. It is better to heat the pipes than the oil or tar. The bottoms of vessels are frequently tarred as a protection.

Wrought iron, when highly heated in air, oxidizes in readily detachable layers of scale. It would be advantageous, but not convenient, to paint it while hot, as it comes from the mill. Pickling three or four hours in a two per cent. sulphuric acid solution, then rinsing and scouring with sand, prepares sheets for painting; if they are to be kept before painting, they should be treated with caustic lime-water.

Cast iron should be protected from rust by a priming coat as soon as possible after leaving the mould. But *painting* castings at once prevents one from seeing whether or not they are free from flaws or air-bubbles; *dipping in oil* is for this reason better than painting as a priming coat. Parts of machinery for storage or shipment may be either tallowed or coated with white lead, or with a solution of paraffine in benzine or in turpentine.

Paint on buildings is subject to the action of air, light, moisture, moderate heat, cold, dust, and abrasion; in some parts to that of sulphurous and ammoniacal gases. On vessels we may add to the above the action of salt water. On machinery there is especial liability to the action of oils and steam; pickle tanks in foundries, to acids; lye-tanks, to alkalies; bleacheries, to sulphur and chlorine; cesspools, to sulphureted hydrogen; stables, to ammonia in addition. Cast-iron service-pipes laid in wet clay get soft and rotten; wrought-iron tubing also deteriorates in the same situation. Connecting rods on ocean steamers are liable to the combined action of oil, tallow, heat, and salt water. Smokestacks are subjected to a heat of 300° to 600° F. Locomotive furnaces and smoke-boxes are much hotter.

Soluble Glass is an artificial silicate of soda or potash, or of both. It is highly fire-proof. Paints containing silica are used for both wood and metal; give a hard, durable surface; and, when properly oil-mixed, resist acids and salt water better than ordinary iron or lead paints. They cover well and are flame-resistant—the last quite an advantage in building—especially on wooden trimmings and cornices. They mix admirably with oils, but are stiff to apply in cold weather. Some of them are excellent for pickle-tanks, etc. Walls are sometimes rendered impermeable to moisture by spraying silicate upon them. "Ransome's Fireproof Paint" is silex and soluble silicate, chloride of calcium being applied afterward.

In a well-known and patented "chemical paint," largely made of silicates, there is produced a perfect emulsion in the following manner: A mixture of solutions of acetate and sulphate of zinc is mixed with one of soluble soda silicate; lime-water is added; next, linseed oil; the base (generally white lead or zinc white) is then added, and the paste "thinned down" with any suitable diluent; the whole is then re-ground to insure and maintain perfect combination or mixture.

Yellow Ocher is a term usually applied to yellow ferruginous mud or rock, although "ocher" should be only a hydrated peroxide of iron. The ocher pastes are fine, smooth, opaque, dull, adherent to the tongue, and having a clayish smell when wet; should be greasy and easily ground. When yellow ocher is calcined it becomes *red* ocher.

Raw Sienna, a warm, yellow, earthy pigment, is clay-colored by peroxide of iron and manganese; it works well in oil or in "distemper."

Fullers' Earth, a sandy, clayey earth, comes both blue and yellow. It is, correctly, a very fat kaolin, and should not really have sand therein. It is best mixed with water, and answers well with lime, which it improves in adhesiveness.

Lampblack (so called because the term was applied to the collected soot of lamps).

Painting should not appear like a smooth, shining film or skin, but should have a fine, regular grain. Painting dry wood protects it from external deterioration. Painting damp wood hastens its internal decay.

Pine wood should have the knots "killed" by coating with red lead ground in size, or with shellac "cut" in naphtha or alcohol. (The former method causes roughness.) Nail-holes and cracks may be puttied up, the surface smoothed and sand-papered; the priming coat need have little color in it. Putty in nail-holes holds best if applied after the priming. It is better to fill with sawdust and glue, as putty shrinks. Ordinary woodwork should have at least four coats; floors, five to seven. Many thin coats are better than the same weight in heavy coats. (This is especially noteworthy.)

Concerning the first coat—oil dries more slowly than oil and white lead, but more rapidly than oil and zinc white. On brass wire and zinc, oil dries as rapidly as oil and white lead, but more rapidly than oil and white zinc. On the brass wire the drying is more rapid than on the zinc. On iron the results are the same as on zinc. On porcelain and glass, oil dries more quickly than oil and white zinc; oil and white lead still more quickly. On plaster the oil and the white zinc paint dries in about equal time. On poplar and mountain ash, oil dries more slowly than oil and either white lead or white zinc. Testing these three coatings on copper, brass wire, zinc, iron, and lead, oil and white lead dried more quickly than oil and white zinc; the same on porcelain, glass, poplar, and mountain ash.

Paint dries more quickly on poplar than on oak; on pine than on poplar; on painted than on fresh wood surfaces. Zinc white, although a rapid drier, retards the drying of subsequent coats.

Paint dries more quickly at from 77° to 82° F. than from 59° to 64° F.; hence more drier must be used in winter than in summer.

It is extremely difficult to get paint to adhere to zinc. If the sheets are brushed with a mordant of 1 part chloride of copper, 1 of nitrate of copper, 1 of sal-ammoniac, 64 of water, and 1 of muriatic acid, the paint will *stick*.

BLACK STAINS FOR WOOD.

1. *Treatment with Logwood by the Aid of Heat.*—In 2¼ to 2¾ lbs. hot water 9 ozs. logwood are well boiled; 1¼ oz. of blue stone is added, and the clear liquid, after settling, is decanted, and in this is steeped, while hot, the wood to be stained, and allowed to remain for twenty-four hours, after which it is exposed to the air, to permit the oxidation of the coloring matters. The wood is then steeped in a hot solution of nitrate of iron at 4° Baumé. If not perfectly black, it must be steeped for some hours in the first bath.

2. *Treatment with Logwood in the Cold.*—Mix in a copper vessel 11 lbs. rasped logwood, 8¾ lbs. galls in powder, and 35 lbs. wood vinegar. Digest for eight days with frequent stirring, add 11 lbs. water, evaporate down to one-half, and decant. In the meantime mix in an earthern bowl 2¼ lbs. iron filings and 8¾ lbs. wood vinegar, and when the liquid, by spontaneous evaporation, stands at 13° or 14° Baumé, decant and mix it with the other liquor, stirring well. Let settle and decant afresh, so as to obtain a clear liquor, in which the wood to be stained is steeped for a longer or shorter time, according to its hardness. The oxidizing action may be hastened by adding about 15 grains of oxalic acid. A similar dye, sold under the name of tincture of Paris, is prepared by dissolving solid extract of logwood in hot water till it stands at 10° Baumé, and then to every 8¾ pints add 4½ pints of black liquor at 11° Baume and 17 fluid ounces of acetic acid at 2° Baumé. Heat for a quarter of an hour, let settle, decant, and use cold.

3. *Treatment for Veneers.*—Heat the veneers for half an hour in soda-lye at 10 per cent., and let them soak in it for twenty-four hours. Prepare then a solution of copperas at 3 per cent., and plunge into it the veneers at 113° Fahr., previously freed from soda by repeated washings, and dried after having been steeped for twenty-four hours in a hot and concentrated decoction of logwood. Veneers thus prepared are supple as leather, and have the shade of the finest ebony.

4. *Special Treatment for Oak.*—Boil one part of rasped logwood in 10 of water, filter, evaporate carefully to one-half, and add to half a gallon 10 to 15 drops of a saturated solution of neutral extract of indigo. Prepare the pieces of oak by steeping them for forty-eight hours in a solution of alum saturated when hot, and plunging them into a decoction of logwood. Sprinkle them then with the liquid above mentioned, and rub them with a cloth moistened with verdigris dissolved in strong acetic acid. If properly managed, the oak will become equal to ebony.

5. *Treatment with Aniline Black.*—Dissolve 50 parts of aniline in 100 parts of muriatic acid and 1,000 of water, and steep in it the wood, previously prepared in permanganate of potash. The wood is then washed in soap-lye or in bichromate of potash.—*Union Industrielle.*

CLEANING OIL PAINTINGS.—To clean old oil paintings so that color contrasts may be rendered more visible, the picture is first freed from dust with a feather, and washed with a sponge and water. A layer of soap is then applied (the author suggests shaving soap), which is allowed to remain on for eight or ten minutes, after which the soap is washed off with a brush, and the picture left to dry. A small piece of linen cloth is then saturated with nitro-benzine, and with this the picture is cleaned. All dirt is in this way removed, and the picture stands out bold and distinct. In the end, olive oil may be applied, and subsequently a quickly drying varnish.

RESTORATION OF WRITING.

IN some cases the ink is not very old when it begins to grow yellow and faint, and this baffles any photographer who desires to produce a transparent image of the writing on his collodion plate, in order to turn the same into a photo-lithographic transfer, if need be. Herr von Bibra applied freshly prepared sulphide of ammonium to the indistinct passage, and in a few moments the writing begins to come out clearly. The excess of sulphide is got rid of by rinsing with cold water (the use of the wash-bottle is recommended), and the MS. then carefully dried either by gentle heat or between blotting paper. It does not matter whether the material on which the writing appears is parchment or paper. The blacking does not last very long, but if it fades again, a solution of tannin applied in the same way will bring it out clearly once more. As it is only in the very earliest times that charcoal and Indian ink were employed in MS. (and when this was done the writing is not likely to have faded), Herr von Bibra's receipt is likely to be of very general use, since gall ink is of a very ancient character.

KALLAB'S BLEACHING PROCESS.—The essential part of this invention lies in the production of a permanent blue tint. The wool, previously scoured, etc., is taken through a beck in which 7½ to 15 grains of indigo are suspended per 22 gallons of water, next through a solution of hydrosulphite of soda; acetic acid is then added to the solution and the wool is then taken through again. To every 35 fluid ounces of the solution of hydrosulphite, which should stand at 4° Baumé, about 300 grains of acetic acid at 50 per cent. are added. After passing through this liquid the wool is exposed to the air, washed first in a weak soda-lye and then in pure water, and finally dried at 95° Fahr. The indigo, which was at first only deposited mechanically upon the fiber, is reduced by the hydrosulphite beck to white indigo and then reprecipitated upon the fiber as indigo blue. The tint is, therefore, a vat blue and perfectly fast.—*Reimann's Faerber Zeitung.*

SCAMONI'S PROCESS OF PHOTO-GRAVURE.

IN the *Bulletin* of the Belgian Photographic Association we have a description of Scamoni's process of photo-gravure, which gives the details of the method by which the negatives and positives are prepared, from the latter of which electrotypes are taken to form the plate, whence impressions are pulled in a copper-plate press. The originals which have to be reproduced are carefully touched up, so that the whites are as pure and the blacks as intense as possible, and then the negative is taken in the ordinary way, the plate being backed in the camera with damp red blotting-paper, to prevent reflection from the camera or back of the plate.

The negative is developed in the ordinary manner, intensified by mercuric chloride, and varnished. A positive picture is taken in the camera, the negative being carefully screened from any light coming between it and the lens. This is intensified by pyrogallic acid, and afterward washed with a pure water, to which a little ammonia has been added. It is then immersed in mercuric chloride for half an hour, and again intensified with pyrogallic acid. This is repeated several times. When the intensity of the lines is considerable, the plate is well washed, treated with potassium iodide, and finally with ammonia, the image successively appearing yellow, green, brown, and then violet brown.

The plate is then thoroughly drained, and the image is treated successively with a solution of platinic chloride, auric chloride, ferrous sulphate, and finally by pyrogallic acid, which has the property of solidifying the metallic deposits.

The metallic relief thus obtained is dried over a spirit lamp, and covered with an excessively thin varnish. This varnish, which is evidently a special preparation, retains sufficient tackiness to hold powdered graphite on its surface (the bronze powder now used may be employed instead), which is dusted on in the usual manner. After giving the plate a border of wax, it is placed in an electrotyping bath, and, after a few days, a perfect fac-simile in intaglio is obtained.—*Photographic Journal.*

A LUNAR LANDSCAPE.

MESSRS. GAMMON & VAUGHAN, No. 28 Old Bond Street, London, have at present on view a picture in which the artist Olafs Winkler, of Weimar, has endeavored to represent a lunar landscape. Prof. C. Bruhns, of Leipzig, has assisted him in the parts of the treatment which are directly scientific.

The painter has not trusted all to his imagination. He has, to the best of his knowledge and ability, sought to stick rigidly to truth, and to paint a lunar landscape such as it would appear, so far as human observation has hitherto ascertained, to a human eye, were it at all possible for a man to be transplanted to the moon and observe through his earthly eyes, only for a moment, nature as she manifests herself on the surface of our satellite. From the merely artistic point of view the artist fears his task may be a thankless one, for since the moon has no atmosphere, there is neither aerial perspective nor diffusion of light, but it is precisely this point which should make our artist all the more interested in this unique production. The shadow of a body in the foreground will appear quite as black as the sky itself, which closes the landscape like a flat steep wall, broken only by the quiet light of the stars. All lights appear equally strong at a distance and close at hand, and this also holds with the local coloring. In a word, there is wanting in the lunar landscape that which lends to our earth perspective, richness of tone, modulation, softness, and temper. It is our atmosphere we have to thank for most of the multitudinous colored phenomena of the terrestrial landscape—phenomena which in our satellite are impossible. The sunlight falls upon the hills with blinding brightness, and cuts sharply across the deep black shadows. Its intensity rivals the electric light, and light effects of such a kind are far beyond the reach of our palettes. We must resort to some expedient to be able to introduce a medium between the extreme contrast of light and shade, a sort of half-tone, which, at the same time, must be the chief tone of the picture; this Herr Winkler has sought in the light of the earth, the true "earthshine."

The artist has chosen the time of sunset, and the region he has selected lies in the northern part of the moon. The spectator is supposed to be on the front slope of a mountain, the continuation of which in the background comes out as a closed ridge. At his feet one of the numerous *maria* spreads out, filled up with rills, circular hills, and large and small craters, stretching away to the distant mountain referred to. Before us, in the black sky, hangs the moon's moon, our earth. She sheds her pale, ash-colored light over the rent, desolate, dead stone-fields. Only the highest points of the mountain-tops still glow in the light of the setting sun, no longer red, as here, but dazzlingly white, in consequence of the absence of atmospheric absorption. The earth is at the period of her course between Sagittarius and the Scorpion, Antares being nearly in the middle of the picture. Against his persuasion he has been compelled to make the milky way very weak, and the stars somewhat large in proportion to the earth.

Herr Winkler, in a paper read at the last meeting of the German Association, stated that his first impulse to under-

take the picture was derived from Nasmyth and Carpenter's work on the moon.

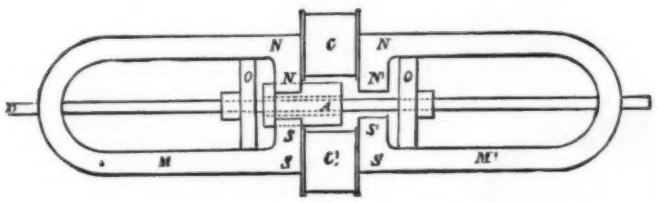
Our only criticism of the picture refers to the color of the earth and of the true earthshine. We doubt whether the earth is quite red enough, especially at the edges, and we doubt again whether, with the earth as ruddy as it is, the color of the lunar landscape itself should not be rather more in harmony with it, as it is the true light source.

The picture is an admirable performance, and the science of it is so true that, as we hinted before, those of our artists who care to have a natural basis for their depiction of natural phenomena will learn much from this attempt to deal with a new order of phenomena.—*Nature.*

VARLEY'S MAGNETO-ELECTRIC MACHINE.

THE principle and chief features of novelty in this machine mainly consist in maintaining actual or nearly actual contact between the armatures and poles of the inducing magnets. The magnets themselves, together with the intermediate cores, are surrounded by helices, and form complete magnetic circuits, so that the magnetic poles of the permanent or electro-inducing magnets have their respective north and south poles continuously, or nearly continuously, closed, notwithstanding the movement of the armature or armatures, but which armature or armatures, when rotated or moved to or fro along the iron ring or link included in or forming part of the continuous magnetic circuit, alters the direction of the magnetic conduction through the inducing cores surrounded by electric conductors; the effect of which alteration is to generate electricity in the conductors forming the helices. The armatures being in actual or nearly actual

FIG. 1.



contact with the inducing magnets insure a more perfect magnetic conduction through the intermediate cores with which the inducing magnets form an unbroken magnetic circuit, so that a very large percentage of work done in giving motion to the machine is converted into electric energy.

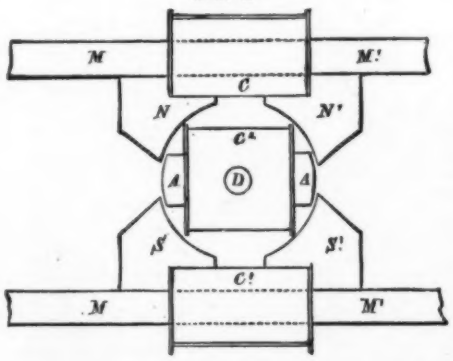
A machine on this principle, in its simplest form, consists of two horse-shoe magnets placed opposite one another, and with two soft iron cores, on which coils of covered wire are wound, placed between their poles. The two north poles of the magnets are in contact with the two ends of one of the cores, and the two south poles are similarly placed in relation to the other core. Together with these, which are fixed parts of the apparatus, there is an armature to which a reciprocating motion is communicated, which places it first in contact or nearly so with the two poles of one magnet, and then transfers it to a corresponding position in respect to the

FIG. 2.

other magnet. To increase the area of the surfaces in contact or close proximity, the faces of the magnets and of the armature may be grooved. The armature may also be made double, so that the poles of the magnets may be received between its two parts. The attraction of the magnet for the two parts of the armature will then balance each other, and by a screw adjustment the surfaces of the armature may be brought very close to the surfaces of the magnets without giving rise to friction. In place of a reciprocating armature a rotating armature may be employed, so formed as to connect the north pole of one magnet with the south pole of the other, and as it rotates to couple the poles alternately.

In Fig. 1, M and M¹ are horse-shoe magnets; permanent magnets are represented, but electro-magnets are also available. Between the magnets and in with them are two cores of soft iron wound with coils of insulated wire, C, C¹; they

FIG. 3.



form part of the circuit or circuits in which the electricity generated by the apparatus is transmitted. N, S, and N¹, S¹, mark the poles of the magnets M and M¹. O, O, are guides made of gun metal in which the rod D is free to slide to and fro; it has upon it the armature of soft iron marked A. A reciprocating movement may be communicated to the armature between the guides, O, by connecting the rod D directly or indirectly with a steam engine or other motor. It will be observed that in this arrangement no reversal of the magnetism in the armature A takes places.

Fig. 2 is an end view of the armature A showing how it is grooved into the horns of the permanent magnets M, M¹. Fig. 3 shows the rotating armature arrangement. The armature is mounted upon a rotating axis D, and as it revolves it alternately closes the pole N with S¹ and N¹ with S. In this arrangement the magnetism in the armature A is reversed in each rotation, and the armature carries a coil C², so that electricity will be generated in the circuit of which this coil forms part. An ordinary rotating commutator may be included in the circuit and the electricity can then be employed to excite the magnets M, M¹, when electro-magnets are employed.

THE CHAINS OF EGYPT.

THE ride to Kasr el Shama takes the sightseer through a labyrinth of small streets to the southern gate of Cairo, named after the lady Zeynab, a granddaughter of the Prophet, and thence over immense heaps of rubbish, the ashes of Fostat, burnt in 1168, until the open country is reached. The heaps extend for miles in this direction, and may mark the site of cities older by far than the tabernacles which Amer pitched on the spot in 638, and which supply a meaning for the Arabic name. This was Babylon, not indeed Babylon the great, but the town which Cambyses is said to have founded, and whence, according to some, the Epistle of St. Peter was written. Whether Strabo, when he speaks of a Babylonian colony here, refers to the extradition of a number of families by the Persian King, or whether, as his words seem to imply, a much older settlement is described, cannot now be decided. It is curious, however, to note that other authors have spoken of the colony in very similar terms, and that it is sometimes ascribed to "Sesostris," or Rameses II., who is here said to have placed his captives from Babylon, and sometimes to Semiramis. The most recent writer who has touched on the subject is Mr. Roland Michell, and in his volume on the Egyptian Calendar a conjecture is mentioned which would account for the modern name of the Roman fortress at least. Kasr el Shama—or, as it is pronounced, "esh Shemmah"—is in English the Castle of the Flame or Light, and may mark the site of a temple of fire-worshipers. Be this as it may—and no more plausible derivation has been suggested—there are no Persian remains now to be seen at Babloun, and the unobservant traveler might very easily pass by the Roman walls half buried in gray mounds, though they would well repay, what they have never yet received, a careful survey.

The western face now consists of a long wall of large stone blocks, under which a low entrance has been burrowed, leading into a very rabbit warren of miserable dwellings, Coptic churches, Moslem mosques, monasteries, synagogues, and bazaars, uniform only in dirt and vermin. To the ecclesiastical antiquary there is much worth seeing among the strange piles of mud and brick. But passing by the entrance and continuing along the outer wall, two well-defined semi-circular bastions, once pierced with arched windows, or embrasures, recall similar buildings at York, in London, at Trèves—anywhere, in fact, where the military engineers of old Rome built their fortresses. There is no mistake about the banded masonry, the thin bricks, the hard mortar, or any other of many marks by which Roman work may be identified; though high up, with the wall for a foundation, a tall whitewashed dwelling looks over, and seems tottering to a fall. This western front is perhaps two hundred yards long, and ends with another semicircular tower facing south. This tower is very perfect to a height of perhaps twenty feet, and is the first of a series of three, each some fifty feet in width, which range along the same side—the side, that is, which looked toward Memphis. If we climb the mound in front, the wide green plain with its palm groves across the river stretches for miles over the site of the vast city, and the tombs of the inhabitants still cluster round the pyramids on the hill beyond. From the gate between two of the bastions, now sunk in ashes to the top of its pedimented archway, the soldiers of Cæsar watched the Nile and held the chief link in the chain which bound Egypt and Memphis to Rome. A few years ago there was still a trace of an eagle carved beside the arch, and everything is in a style wholly foreign and different from the native Egyptian work. To the English archæologist this Roman castle is peculiarly interesting. Just as our Royal Engineers build a barrack at Agra and one at Armagh on the same lines and in the same style, so the Romans had but one general pattern for their pretorium, whether it was situated at Colchester or Paris, on the Danube or on the Nile. Just such a fortress as this formed the kernel of old London. Its foundations, with the banded masonry and the semicircular bastions, were discovered when the soil of Cannon Street was upturned for the new station. Long before the wall was drawn round the outer ring of suburbs, before the British London had become the Roman Augusta, a fortress which must have closely resembled this at the Egyptian Babylon crowned the hill on the eastern bank of the Walbrook, and commanded the little port at Dowgate below.

Very different in every way is the fort at Dakkeh in Nubia, yet strangely like another type of military architecture with which we are familiar in England. The voyager who ascends beyond the First Cataract finds himself in a narrow valley shut in by granite hills, and only sees here and there a space wide enough for cultivation. There are buildings of all ages and kinds, chiefly temples; and at intervals, where the sandstone ridges approach the Nile, he finds vast grottoes carved in the face of the cliff, the greatest of all being the furthest—namely, the Temple of the Sun at Aboshek, better known as Ipsambool. Amid this wealth of architectural remains, the best of them on the western bank, the castle opposite Dakkeh, on the eastern bank, is very often passed by unvisited. Yet it well repays a visit, though the visitor wishes in vain for some one competent to describe the defenses as Mr. Clark would describe a Norman Keep in England. For, though it is built of crude brick—that is to say, of mud—and though it is seven hundred miles from the sea, and though it is one of the oldest buildings in the world, having been erected 2,500 years at least before the White Tower, yet to the eyes of an English traveler it resembles nothing in the world so much as the Keep of Rochester or of Guildford. There is the ditch, with scarp and counterscarp. There are square towers overlapping the corners. There are flat buttresses not reaching the top of the wall. There are gates with narrow walls and signs of drawbridges. There is a covered way down to the water's edge. We might be exploring a castle on the Thames or the Dee, except for the material of which it is built. The walls, some fourteen feet thick at least, and still in places not less than forty in height, are all formed of great blocks of sun-dried mud, very like the sods of peat one sees in Scotland or Ireland. Here and there the impress of the maker's hand may be found, and you may lay your fingers into the very marks left by a man of flesh and blood, of nerves and muscles, of skin with a thousand delicate lines such as you see in your own palm, yet who lived and labored and died more than three thousand years ago. Some of the marks are small, and must be those of a woman's hand; for female labor, by which to-day the new streets of Cairo are built, was, no doubt, the rule in Egypt under Hatasoo as it is under Ismael. Of the history of the fortress opposite Dakkeh, of its very name, we know nothing. Centuries before Joseph or Moses, centuries before the siege of Troy, tens of centuries before William the Norman, monarchs had castles built for them, and employed the labor of their subjects to forge and strengthen their own chains.—*Saturday Review.*

ROYAL ASTRONOMICAL SOCIETY.

LORD LINDSAY, M.P., President, in the chair, April 12.

Captain Abney read a paper "On the Photography of the Red End of the Spectrum." He said that about two years ago he had read a preliminary note upon the subject, in which he stated that he had succeeded in obtaining photographs of parts of the spectrum as far below A as A is below D. He had not then shown any of his photographs, and had promised a further paper on the subject, and he thought it right now to redeem his promise by giving some further information on the subject. He had, by the use of gums and a method which he did not explain, succeeded in obtaining emulsions which were sensitive to the red end of the spectrum. His theory was, that by this means he had obtained a larger and more complicated molecule which was sensitive to longer wave-lengths than the ordinary iodide of silver molecule. Some of the photographs which he had obtained were thrown upon the screen by means of the electric light. It appeared that the plates, as prepared by him, though sensitive to the red and ultra red parts of the spectrum, were not sensitive to the yellow rays; there was consequently a gap extending from a little below E to C. In the photographs which were taken with a diffraction spectrum, the lines were beautifully sharp. He had submitted them to Professor Piazzi Smyth, who said that the photographs reminded him of the red region of the spectrum as seen under the best conditions in the clear atmosphere of Spain.

Mr. De La Rue complimented Captain Abney on the important discovery which he had made, and asked whether he had made any progress in the direction of producing colored photographs similar to those which had been taken by M. Becquerel some years ago.

Captain Abney said that, in a paper which he had read before the Royal Society, he had stated that he believed he had discovered the explanation of these colored photographs. The coloring depended upon the different oxidizing powers of the different wave lengths of the spectrum.

Lord Lindsay asked Captain Abney how he had managed to focus for the ultra-red parts of the spectrum. He had noticed that the lines on his photographs were very sharply defined; but he concluded that the focusing must have been obtained by a tentative process.

Captain Abney said that he had not come to the society to be pumped. He had, however, obtained the focus by a tentative process. It would be seen that there were lines upon the photographs, which could not be seen with the eye, and there were groups of lines distinctly defined upon the photographs, which could only be seen with the greatest difficulty in observing the spectrum.

Lord Lindsay said that he felt sure that the society would join with him in returning a most cordial vote of thanks to Captain Abney for his interesting communication. He would only add that when a paper of such interest was brought before the society the fellow making such communication must not mind a little cross-examination, and should remember the pleasure and information he was affording to the other fellows of the society.

Mr. Jenkins read a paper on the "Luminous Spot on Mercury in Transit." After referring to the records of the observations of transits of Mercury made during the last 170 years; he came to the conclusion: (1) that in the May transits, when Mercury is near aphelion, the luminous spot is in advance of the center of the planet, whereas, in the November transits, when the planet is near perihelion, it appears that the luminous spot follows the center; (2) the luminous spot has never been seen at the center, but always a little south of it, and it cannot be due to diffraction; (3) in some of the transits two spots have been seen close together where shortly before only one was observed; (4) in the May transit the rings round the planet are dark and nebulous, while in the November transits they are bright. In the two transits most accurately observed—namely, those of May, 1832, and November, 1868—the contrast was found to be very great and typical. In the 1832 transit there was a diffused spot preceding the center with dark rings round the planet, while in the 1868 transit there was a sharply-defined spot following the center, with bright rings surrounding the planet. Mr. Jenkins therefore concluded that on the 6th of May next, when Mercury will be near aphelion, the luminous spot will not be a point of light with no sensible diameter, but a diffused spot rather to the south of the center, and the planet will be surrounded by dark nebulous rings, and not by light ones.

Mr. Green showed some drawings of the planet Mars, made by Mr. Schiaparelli, of Milan. They showed very remarkable chain-like or mottled structure about the equatorial regions of the planet, and Signor Schiaparelli was of opinion that important changes had been going on upon the surface of the planet since the time it was in opposition. Mr. Green and other gentlemen who took part in the discussion were, however, of opinion that, considering the small apparent diameter of the planet at the time that the observations were made, and the smallness of the instrument with which the planet was observed, the evidence of the changes must be received with very great caution.

CHINESE PROVERBS.—Human nature is very much the same throughout the world, and there is a touch of the homely and practical in the great mass of Chinese proverbs, as well as an originality of diction. "Brothers in the morning, enemies at night." "A man known well is a treasure." "Every man loves his own skin and flesh." "If you honor your own parents at home, why go afar to burn incense!" "Out of the broken kiln come very good tiles." "A prodigal, when he repents, becomes a priceless treasure."

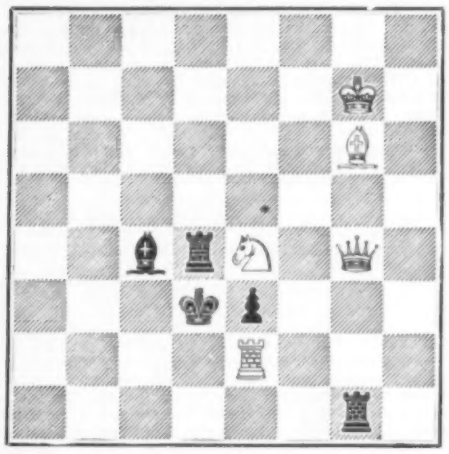
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N J.]

PROBLEM No. 82. BY SAMUEL LOYD.

Prize in *Frank Leslie's* Problem Tournament, 1855.

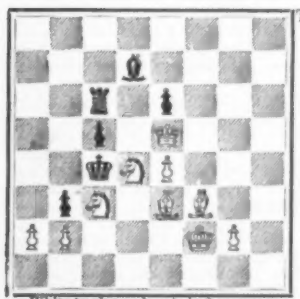
Black.



White.

White to play and mate in three moves.

SAMUEL ROSENTHAL, OF PARIS.



White to play and mate in 2 moves.
BY EUGENE B. COOK.

AT the present moment, when the attention of the chess world is interested in the forthcoming Paris Tournament, we select this appropriate occasion for introducing to our readers the portrait of Mr. Rosenthal, into whose hands the management of the Tournament has been intrusted. Mr. Rosenthal is a player of many years' standing, who has long ranked as one of the most brilliant of European players, and has of late years been generally accepted as the strongest French player, and is referred to as the Parisian champion. We differ upon this point, however, for having played many games with Mr. Rosenthal, and seen much of his play, we can only liken his play to that of the late Mr. Cochrane—dashing in the extreme, but utterly futile against the solid play of Kolisch, or the French champion, De Riviere.

Perhaps few players win more off-hand games than Mr. Rosenthal—a fact of considerable importance to one who depends upon chess for a livelihood—yet, as a match or tournament player, we know of few who have been less successful.

Mr. Rosenthal is a Pole, exiled from his country on account of political proclivities, and attracted to Paris by the sympathy of the late French Emperor, who allowed a small annual pension to all Polish refugees residing within his realm.

Mr. Rosenthal is a clever solver, and is well versed in the problematical tricks of the day, and is not often caught napping as in the Paris Tournament of '68, when we sprang a little three-move trap on him. [See SUPPLEMENT No. 103; the game is given in the last edition of the *Handbuch*.]

He has lately made his début as a blindfold player, and has most successfully rivaled the famous performances of Paulsen, Blackburne, and Zuckertort, and in this respect is unquestionably one of the most skillful players of modern times. We select one of his blindfold games which will be found to be a marvel of accurate and finished play.

FRANK LESLIE'S PROBLEM TOURNAMENT OF '55.

WE are somewhat in doubt in regard to the correct record of this Problem Tournament, inaugurated by Mr. W. J. A. Fuller, the first chess editor of *Frank Leslie's Illustrated Newspaper*. But having been a competitor, and desiring to give a record of the same, we are compelled to draw upon our memory for the following facts:

Three prizes were offered for the best problems in three, four, and five moves, the first of which was awarded to our Problem No. 83, the second to the following four-move position, which is remarkable only for its "old style:"

ENIGMA No. 48.—BY SAMUEL LOYD.

White.—K on K Kt sq, Rs K 4 and Q B 2, Bs K Kt 7 and K R 5.

Black.—K Q 6, Q Q R 3, Rs Q Kt 5 and K R 2, Kt Q 5.

White to play and mate in four moves.

The third prize was considered to be doubtful, and the honors were evenly divided, therefore, between T. M. Brown and Isaac S. Loyd, a brother of the editor, who has entirely withdrawn from chess for over a score of years. The position we give as No. 83, but are somewhat in doubt as to the five-move problem by Mr. Brown, but believe it to be as follows:

ENIGMA No. 49.—BY T. M. BROWN.

White.—K on Q R 3, Q K Kt sq, R K Kt 8, Kts Q Kt 5 and Q 3, Ps Q Kt 2 and Q R 2.

Black.—K Q B 5, Q K R 5, Bs Q sq and K R 2, Kt K B 6, Ps Q R 4, Q 3, K 5 and 7.

White to play and mate in five moves.

THE following is one of eight blindfold games played simultaneously by Mr. Rosenthal, at a *séance* given at Paris a short time since:

(*Evans Gambit.*)

M. ROSENTHAL. WHITE.	M. FEISTHAMEL. BLACK.
1. P to K 4	1. P to K 4
2. Kt to K B 3	2. Kt to Q B 3
3. B to B 4	3. B to B 4
4. P to Q Kt 4	4. B x P
5. P to Q B 3	5. B to B 4
6. P to Q 4	6. P x P
7. Castles.	7. P to Q 3
8. P x P	8. B to Kt 3
9. Kt to Q B 3	9. Kt to Q R 4
10. B to K Kt 5	

This is a strong attack in the Evans Gambit, but not so much in favor as the retreat of the B to Q 3, followed by P to Q 5, which leads up to a common form of this opening by a transposition of moves.

	10. P to K B 3

Black is now virtually deprived of the privilege of castling on the K side. The best defense is Q to Q 2, followed next, on the adverse B retiring to Q 3, by P to K R 3, thus gaining, without loss of time, an outlet for his K after castling on the K side, which makes all the difference from playing P to K R 3 spontaneously. Then he may either proceed by Kt to K 2, or else play P to Q B 3 preliminary to bringing out the Kt with a safe game.

11. B to R 4	11. P to Q B 3

It was of no use taking the B, for white would recover the piece by Q to R 4 ch.

12. B x Kt	12. R x B
13. R to K sq	13. K to Q 2

SAMUEL ROSENTHAL, OF PARIS.

The K had to make his escape against the threatened P to K 5, and K to B sq only subjected him to a different sort of attack, which, however, was not less intense.

14. P to K 5	14. P to K Kt 4
15. B to Kt 3	15. B to B 2

P to K B 3, with the intention of pushing his P on to B 5, would have been worse than useless; for white would have answered simply P x P, threatening to win the Q by Kt to K 5 ch, followed accordingly by Kt to B 7 ch, or else by Kt x B P dis ch.

16. P x B P	16. Q x P
17. Kt to K 4	17. Q to Kt 3
18. Kt to Q B 5 ch	

The offer of this sacrifice is very fine, and highly creditable to the performer, who manifestly holds the position tight in his memory.

	18. K to Q sq
19. P to Q 5	19. P x P
20. Q x P	20. Kt to Q B 3
21. Q R to Q sq	21. Kt to K 2
22. Kt x P ch	22. B x Kt
23. Q x B	23. R to B sq
24. B x P	

The end is executed with great accuracy, and is well adapted as a finale to a game conducted by the blindfold player throughout with well-trained judgment.

	24. R to Kt 2
25. B x Kt ch	25. K to K sq
26. Q x R ch	26. K to B 2
27. Q to B 8 mate.	

THE PARIS CHESS CONGRESS.

DURING the past week we have received an invitation from the committee of arrangement of the forthcoming International Chess Congress to take part in the grand tournament which is to commence on the 17th of June; furthermore, a liberal patron of the game has made us an offer of an excursion ticket including necessary expenses to Paris. We took part in the Paris Tournament of '67, and owing to a press of duties felt that we did not do ourselves credit, and would gladly seize this opportunity of again measuring lances with the European magnates. But in a case like this it assumes almost a national character, and whoever goes to do battle for our country's honor should be selected and recognized as the American champion.

It is now nearly a year since the American Chess and Problem Association was organized and an executive committee formed for the express purpose of arranging a programme for a tournament to select a fitting champion to send to Paris. The committee have been shamefully negligent of their duties, and have shown an utter incapacity for the duties that were imposed upon them, and common decency demands that they resign, and the original motion that was made at the meeting of the Association be adopted, viz., that "an executive committee be formed consisting of all of the chess editors throughout the United States."

We say this with no personal feelings or interests; we are in favor of prompt action of some sort; we headed a list with a contribution of twenty-five dollars to send Mr. Mason as our recognized champion, and will do the same for Mr. Mackenzie, or will give a hundred if it is to be decided by a tournament as originally proposed.

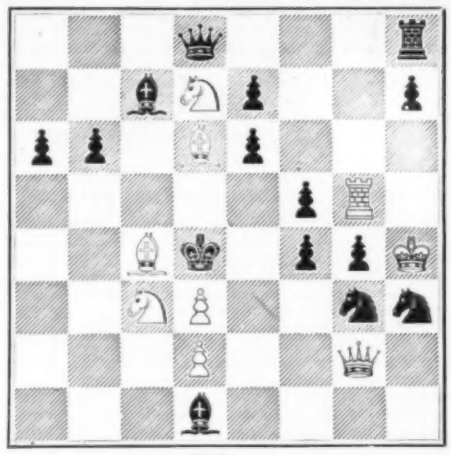
In speaking of the programme of the Paris Tournament Mr. Steinitz says: "The full programme is published in the French journal, *L'Exposition*, which contains a chess column contributed by M. Rosenthal. The principal conditions are the same as given in our issue of the 30th ult. It is now confirmed that the French Government will contribute both the two chief prizes, which will consist of valuable works of art. The regulations of the contest are a great improvement on those of previous Continental tournaments. The *modus* of the Paris Congress of 1867, where only the won games counted, while the drawn games were made equal with the lost games in each competitor's score, as well as the complicated and unsatisfactory match system of the Vienna Tournament, have been justly abandoned. The increase of the time limit to fifteen moves per hour will also meet with the approbation of the large majority of competitors, while the provision that only four games have to be played during one week guards the players against overwork. Altogether, the programme is a most liberal one, and drawn up with the ut most regard for fairness."

The conditions of the Problem Tournament have already been given, and our composers must bear in mind that their entries must be received prior to Aug. 1, 1878. Address M. Camille Morel, 38 Rue De la Borde, Paris.

PROBLEM No. 83. BY ISAAC S. LOYD.

Prize in *Frank Leslie's* Problem Tournament, 1855.

Black.



White.

White to play and mate in five moves.

SOLUTIONS TO PROBLEMS.

No. 76.—BY SAMUEL LOYD.

WHITE.	BLACK.
1. K to Q 2	1. Q checks
2. K or Kt x Q	2. Moves
3. P queens, mating.	
	1. P to Q 4
2. B to Kt 4 ch	2. Kt x B
3. R to R 5 mate.	

No. 77.—BY SAMUEL LOYD.

WHITE.	BLACK
1. B to Kt 3 ch	1. K to B 3
2. B to Kt 4	2. K to Kt 4
3. Q to Kt 7 mate.	
	1. K to K 5
2. Q to K B 2	2. K to Q 6
3. Q to B 3 mate.	
	1. K to Q 3
2. Q to Kt 6 ch	2. K to Q 2
3. B to K 6 mate.	

LETTER "T."—BY J. MUNOZ.

WHITE.	BLACK.
1. Kt to K B 4 ch	1. K to Q 4 or x P
2. Q to K R 3	2. Any move
3. Q to Q 3 mate.	

ENIGMA No. 45.—BY G. H. MACKENZIE.

WHITE.	BLACK.
1. P to Q 5	1. P x Q P
2. Kt to Kt 6	2. P to Q 3
3. Kt x P ch	3. K moves
4. Mates.	

To better show what pleasure may be derived from solving problems, we give an extract from a letter we have received from one of the finest chess players in this country. He says:

"I do not know why, but I had formerly a prejudice against problems, and never would look at them, and now I find many good players with the same feelings; but I have found unexpected amusement and enjoyment in them, and, instead of sitting down with some local player, I now feel as if I had a new and invisible world of chess players to encounter."